HANDBOOK ON SANITATION.

A MANUAL OF THEORETICAL AND PRACTICAL SANITATION.

FOR STUDENTS AND PHYSICIANS; FOR HEALTH, SANITARY, TENEMENT-HOUSE, PLUMBING, FACTORY, FOOD, AND OTHER INSPECTORS; AS WELL AS FOR CANDIDATES FOR ALL MUNICIPAL SANITARY POSITIONS.

BY

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PREFACE

THIS handbook, written and published twelve years ago, has been revised considerably and brought up to date for its third edition.

Primarily intended for health, sanitary, tenement, and other inspectors, the book has enabled a great many persons to gain the rudiments of sanitary science and to fit themselves for positions in the State and municipal services. It is also used as a text-book in some schools and colleges.

Municipal sanitation has made giant strides within the last two decades, and the number of persons making a study of sanitary problems, to whom, therefore, such a volume as this may be of service, is constantly increasing.

The handbook was practically the first in the field in this country and has reached a wide circle of readers and friends in spite of its shortcomings, of which the author is well cognizant, and which I have endeavored to remove in this third edition. I regret that my other official and private duties have made it impossible for me to rewrite the entire book. Besides, however, the many corrections throughout the volume, the chapter

on Ventilation and the section on Foods have been entirely rewritten and considerably expanded.

I trust the book will continue to be in favor with those who are interested in sanitary matters.

31 Union Square, N. Y.
1913.

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HANDBOOK ON SANITATION

PART FIRST

SANITARY SCIENCE

CHAPTER I

SOIL AND SITES

Definition. By the term " soil " we mean the superficial layer of the earth, a result of the geological disintegration of the primitive rock by the action of the elements upon it and of the decay of vegetable and animal life.

Composition. Soil consists of solids, water, and air.

Solids. The solid constituents of the soil are inorganic and organic in character.

The inorganic constituents are the various minerals and elements found alone or in combination in the earth, such as silica, aluminum, calcium, iron, carbon, sodium, chlorine, potassium, etc.

The characteristics of the soil depend upon its constituents, and upon the predominance of one or the other of its composing elements. The nature of the

soil also depends upon its physical properties. When the disintegrated rock consists of quite large particles, the soil is called a *gravel soil*. A *sandy soil* is one in which the particles are very small. *Sandstone* is consolidated sand. *Clay* is soil consisting principally of aluminum silicate; in *chalk* soft calcium carbonate predominates.

The organic constituents of the soil are the result of vegetable and animal growth and decomposition in the soil.

Ground-water. Ground-water is that body of water which is found in the soil at a greater or lesser depth. It comes into the soil from the surface, through the porous part of which rain, melted snow, etc., drain and collect wherever the water reaches an impermeable stratum of ground.

The level of the ground-water depends upon the underlying strata, and also upon the movements of the subterranean water-bed. The relative position of the impermeable underlying strata varies in its distance from the surface-soil. In marshy land the ground-water is at the surface; in other places it may be reached only by deep borings. The source of the ground-water is the rainfall, part of which drains into the porous soil until it reaches an impermeable stratum, where it collects.

The movements of the ground-water are in two directions—horizontal and vertical. The horizontal or lateral movement is toward the seas and adjacent watercourses, and is determined by hydrostatic laws and topographical relations. The vertical motion of the ground-water is to and from the surface, and is

due to the amount of rainfall, the pressure of tides, and to the watercourses into which the ground-water drains. The vertical variations of the ground-water determine the distance of its surface-level from the soil-surface, and are divided into a persistently low-water level, about 15 feet from the surface; a persistently high-water level, about 5 feet from the surface, and a fluctuating level, sometimes high, sometimes low.

Ground-air. Except in the hardest granite rocks and in soil completely filled with water, the interstices of the soil are filled with a continuation of atmospheric air, the amount depending on the degree of the porosity of the soil. The nature of the ground-air differs from that of the atmosphere only as it is influenced by its location. The principal constituents of the air—nitrogen, oxygen, and carbonic acid—are also found in the ground-air, but in the latter the relative quantities of O and CO_2 are different.

AVERAGE COMPOSITION OF ATMOSPHERIC AIR IN 100 VOLUMES

Nitrogen	79.00%
Oxygen	20.96%
Carbonic acid	0.04%

AVERAGE COMPOSITION OF GROUND-AIR

Nitrogen	79.00%
Oxygen	10.35%
Carbonic acid	9.74%

Of course, these quantities are not constant, but vary in different soils, and at different depths, times, etc.

The greater quantity of CO_2 in ground-air is due to the processes of oxidation and decomposition taking place in the soil. Ground-air also contains a large quantity of bacterial and other organic matter found in the soil.

Ground-air is in constant motion, its movements depending upon a great many factors, some among these being the winds and movements of the atmospheric air; the temperature of the soil; the surface temperature; the pressure from the ground-water from below, and from surface- and rain-water from above, etc.

Ground-moisture. The interstices of the soil above the ground-water level are filled with air ONLY, when the soil is absolutely dry; but such dry soil is very rare, most soils, especially near the surface, being more or less damp, and containing what is called ground-moisture.

Ground-moisture is derived partly from the evaporation of the ground-water and its capillary absorption by the surface-soil, and partly by the retention of rain water by the surface soil. The power of the soil to absorb and retain moisture varies according to its physical and chemical, as well as its thermal, properties.

Loose sand may hold about 2 gallons of water per cubic foot; granite takes up about 4 per cent of moisture; chalk about 15 per cent; clay about 20 per cent; sandy loam 33 to 35 per cent; humus about 40 per cent.

Ground-temperature. The temperature of the soil is due to the direct rays of the sun, the physico-chemical changes in its interior, and to the internal heat of the earth.

The ground-temperature varies according to the annual and diurnal changes of the external temperature; also according to the character of the soil, its color, composition, depth, degree of organic oxidation, ground-water level, and degree of dampness. In hot weather the surface-soil is cooler, and the subsurface-soil still more so, than the surrounding air; in cold weather the opposite is the case. The contact of the cool soil with the warm surface-air on summer evenings is what produces the condensation of air-moisture which we call dew.

Bacteria. Quite a large number of bacteria are found in the soil, especially near the surface, where chemical and organic changes are most active. From 200,000 to 1,000,000 bacteria have been found in 1 c.c. of earth. The ground bacteria are divided into two groups—saprophytic and pathogenic. The saprophytic bacteria are the bacteria of decay, putrefaction, and fermentation. It is by their beneficent action that vegetable and animal débris is decomposed, oxidized, and reduced to its elements. To these bacteria the soil owes its self-purifying capacity and the faculty of disintegrating animal and vegetable débris.

Certain pathogenic bacteria may be found in the soil. The germs of tetanus and malignant oedema are sometimes found in soil contaminated with manure, etc. The germs of typhoid fever and cholera may be found in the soil and are brought into it by sewage-polluted water. It is doubtful, however whether these bacteria can be forced out of the soil by the movements of the ground-water and air.

Contamination of the Soil. The natural capacity of the soil to decompose and reduce organic matter is sometimes taxed to its utmost by the introduction into the soil of extraneous matters in quantities which the soil is unable to oxidize in a given period. This contamination or pollution of the soil is due:

(1) to surface pollution by refuse, garbage, animal and human excreta;

(2) to the interment of dead bodies of beasts and men;

(3) to the introduction of foreign deleterious gases, etc.

Pollution by Surface Refuse and Sewage. This occurs where a large number of people congregate, as in cities, towns, etc., and very seriously contaminates the ground by surcharging the surface-soil with sewage matter, saturating the ground with it, polluting the ground-water from which the drinking-water is derived, and increasing the putrefactive changes taking place in the soil.

In soils contaminated by sewage, there may often be found the germs of tetanus and malignant oedema or of typhoid fever and cholera. These germs may get into the ground-water and through that reach the water supply of cities and towns.

Interment of Bodies. The second cause of soil contamination is also of great importance. Owing to the intense physico-chemical and organic changes taking place in the soil, all the dead-animal matter interred in it is easily disposed of within a certain time, being reduced to its primary constituents, viz., ammonia, nitrous acid, carbonic acid, sulphuretted and carburetted hydrogen, etc. But whenever the number

of interred bodies is too great, and the products of decomposition are allowed to accumulate to a very great degree, until the capacity of the soil to absorb and oxidize them is overtaxed, the soil, and the air and water in it, are polluted by the noxious poisons produced by the processes of decomposition.

Introduction of Various Foreign Materials and Gases. In cities and towns various pipes are laid in the ground to conduct certain substances, such as illuminating gas, fuel, coal-gas, etc.; at times the pipes are defective, allowing leakage, and permitting the saturation of the soil with poisonous gases which are frequently drawn up by the various currents of ground-air into the open air and adjacent dwellings.

Influence of the Soil on Health. The older hygienists believed that there is an intimate relation between the soil and the health of people living on damp and contaminated soil.

The influence of the soil upon health depends upon:

(1) the physical and chemical character of the soil;

(2) the ground-water level and degree of dampness;

(3) the organic impurities and contamination of the soil.

The physical and chemical nature of the soil, irrespective of its water, moisture, and air, has been regarded by some authorities as having an effect on the health, growth, and constitution of man. Certain diseases, like cretinism, goitre, and others, have been attributed to a predominance of certain chemicals in the soil.

The ground-water level was thought to be of great importance. Prof. Pettenkofer claimed that a per-

sistently low-water level (about 15 feet from the surface) is healthy, the mortality being the lowest in such places; a persistently high ground-water level (about 5 feet from the surface) is unhealthy; and a fluctuating level, varying from high to low, is the most unhealthy, and is dangerous to life and health. There is considerable evidence that a soil with high-water level is not the best soil to build upon.

A damp soil, viz., a soil in which the ground-moisture is very great and persistent, has been found inimical to the health of the inhabitants, predisposing them to various diseases by the direct effects of the dampness itself and by the fact that wet ground is very difficult to drain and that houses built on damp ground may be damp, especially in their lower parts. As a rule, there is very little to hinder the ground-air from penetrating the dwellings of man, air being drawn in through cellars by changes in temperature, and by the artificial heating of houses.

The organic impurities and bacteria found in the soil are especially abundant in large cities, and are a great cause of the evil influence of soil upon health. The impurities are allowed to drain into the ground, to pollute the ground-water and the source of the water supply, and to poison the ground-air, loading it with bacteria and products of putrefaction, thus contaminating the air and water.

Diseases due to Soil. A great many diseases have been thought to be due to the influence of the soil. At present the only diseases which have been proved to be due to contaminated soil are tetanus and malignant oedema, also cholera, typhoid fever, and dysentery,

which may be caused by the entry of the germs of these diseases into the ground-waters which serve as sources of the water supply.

Sites. From what we have learned about the soil, it is evident that the selection of the site for human habitations is a matter of great importance, for upon the proper selection of the site depend the health, well-being, and longevity of the inhabitants.

The requisite characteristics of a healthy site for dwellings are: a dry, porous, permeable soil; a low and non-fluctuating ground-water level, and a soil free from organic impurities and retaining very little dampness, its ground-water being well drained into distant water-courses, while its ground-air is uncontaminated by pathogenic bacteria. Exposure to sunlight, and the free circulation of air, are also requisite.

According to Parkes, the soils in the order of their fitness for building purposes are as follows: (1) primitive rock; (2) gravel with pervious soil; (3) sandstone; (4) limestone; (5) sandstone with an impervious subsoil; (6) clays and marls; (7) marshy land; and (8) made soils.

It is very seldom, however, that a soil can be secured having all the requisites of a healthy site. In smaller places, as well as in cities, commercial and other reasons frequently compel the acquisition of and building upon sites unfit for the purpose; it then becomes a sanitary problem how to remedy the defects and make the soil fit for habitation.

Prevention of the Bad Effects of the Soil on Health. The harmful effects of the soil upon health are due to the water and moisture in the soil gaining entrance

into the house through the foundation and walls, and through the contamination of the soil by offensive refuse, garbage and sewage.

In order to counteract these effects it is necessary:

(1) To prevent moisture and water from the soil from gaining access into the house;

(2) To avoid all soil contaminations.

All offensive refuse, garbage, rubbish, etc. should be promptly removed from the ground as soon as accumulated and should not be allowed to remain there for any length of time. Such refuse, etc. is best burned. Sewage should be disposed into sewers, otherwise so disposed of as to prevent its polluting the ground.

The prevention of the access of moisture and water into the house may be accomplished by proper house construction and by sub-soil drainage.

The Proper Construction of the House has for its purpose the prevention of the entrance of ground-moisture and air into the house. This is accomplished by building the foundations and cellar in such a manner as to entirely cut off communication between the ground and the dwelling, by putting under the foundation a solid bed of concrete, and under the foundation walls damp-proof courses.

The following are the methods recommended by the New York City Tenement House Department for the water-proofing and damp-proofing of foundation walls and cellars:

Water-proofing and Damp-proofing of Foundation Walls: "There shall be built in with the foundation walls, at a level of six (6) inches below the finished

floor level, a course of damp-proofing consisting of not less than two (2) ply of tarred felt (not less than fifteen (15) pounds weight per one hundred (100) square feet), and one (1) ply of burlap, laid in alternate layers, having the burlap placed between the felt, and all laid in hot heavy coal-tar pitch, or liquid asphalt, and projecting six (6) inches inside and six (6) inches outside of the walls.

"There shall be constructed on the outside surface of the walls a water-proofing lapping on to the damp-proof course in the foundation walls and extending up to the soil level. This water-proofing shall consist of not less than two (2) ply of tarred felt (of weight specified above), laid in hot heavy coal-tar pitch, or liquid asphalt, finished with a flow of hot pitch of the same character. This water-proofing to be well stuck to the damp course in the foundation walls. The layers of felt must break joints.

Water-proofing and Damp-proofing of Cellar Floors: "There shall be laid, above a suitable bed of rough concrete, a course of water-proofing consisting of not less than 3 ply of tarred felt (not less than 15 pounds weight per one hundred (100) square feet), laid in hot heavy coal-tar pitch, or liquid asphalt, finished with a flow of hot pitch of the same character. The felt is to be laid so that each layer laps two-thirds of its width over the layer immediately below, the contact surface being thoroughly coated with the hot pitch over its entire area before placing the upper layer. The water-proofing course must be properly lapped on and secured to the damp course in the foundation walls."

Other methods of damp-proofing foundations and

cellars consist in the use of slate or sheet lead instead of tar and tarred paper. An additional means of preventing water and dampness from coming into houses has been proposed in the so-called "dry areas," which are open spaces 4 to 8 feet wide between the house proper and the surrounding ground; the open spaces running as deep as the foundation, if possible. The dry areas are certainly a good preventive against dampness coming from the sides of the house.

The method illustrated in Fig. 1 is what is required by the Department in the case of brick walls. The method shown in Fig. 2 will be accepted in the case of stone walls, and in the case of brick walls under special circumstances.

Sub-soil Drainage. By sub-soil drainage is meant the reduction of the level of the ground-water by draining all sub-soil water into certain watercourses, either artificial or natural. Sub-soil drainage is not a modern discovery, as it was used in many ancient lands, and was extensively employed in ancient Rome, the valleys and suburbs of which would have been uninhabitable but for the draining of the marshes by the so-called "cloacæ" or drains, which lowered the ground-water level of the low parts of the city and made them fit to build upon. The drains for conducting sub-soil water are placed at certain depths, with a fall toward the exit. The materials for the drain are either stone and gravel trenches, or, better, porous earthenware pipes or ordinary drain-tile. The drains must not be impermeable or closed, and sewers are not to be used for drainage purposes. Sometimes open V-shaped

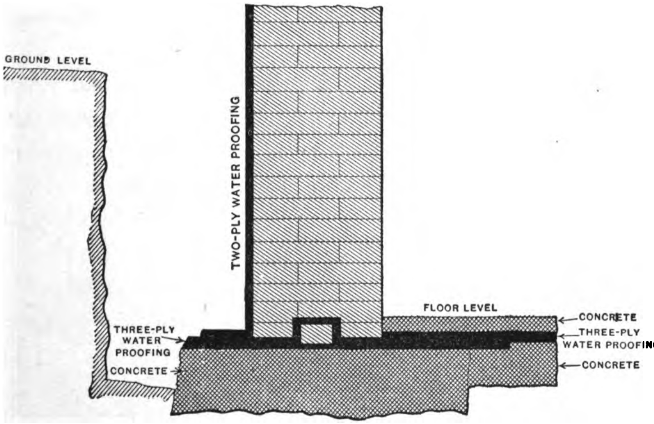

FIG. 1.

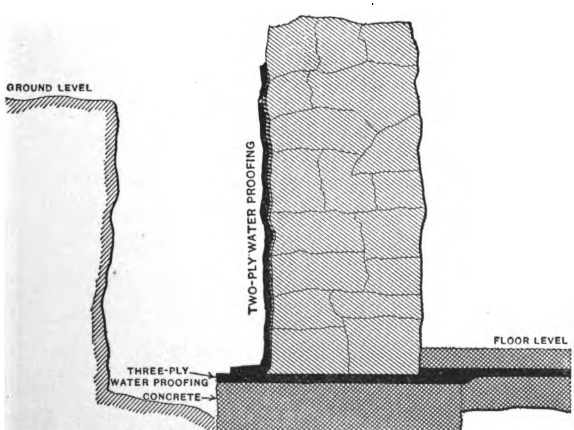

FIG. 2.

CONCRETE FOUNDATION AND DAMP-PROOF COURSE.

pipes are laid under the regular sewers, if these are at the proper depth.

By sub-soil drainage it is possible to lower the level of ground-water wherever it is near or at the surface, as in swamps, marsh, and other lands, and to prepare lands previously uninhabitable, for healthy sites.

CHAPTER II

AIR

Composition. The composition of atmospheric air is quite uniform, and for 100 volumes is as follows:

Nitrogen	78.09
Oxygen	20.94
Argon	0.94
Carbon dioxide	0.03

Beside these principal constituents air contains also Ozone, Helium, Kryton, Neon, Xenon, and Hydrogen.

Nitrogen. The quantity of this constituent is invariable. Its function seems to be that of a diluent of the oxygen in the air, and that of a participant in the various chemical processes of vegetable life.

The *oxygen* in the air varies in quantity but very little, from 20.98 per cent in pure mountain air to 20.87 per cent in the air of cities. The greatest variation exists between inspired and expired air. In expired air the volume of oxygen present is 16.03 per cent, as compared with the 20.87 per cent in city air. Oxygen is the most important of all the air constituents. Oxygen is indispensable to combustion and breathing. When the oxygen in the air is reduced to 7.8 per cent, animals cannot live.

Carbonic acid or CO_2 (its chemical formula) is found in the air in the small average quantity of 0.04 per cent, or 4 parts in 10,000; in pure air there may be less than 0.03 per cent of CO_2; in ground air, in the air of mines, and in holds of badly ventilated ships the percentage of CO_2 may be 10 per 100.

Carbonic acid is the product of organic decomposition and oxidation, and is indispensable to vegetable life, which absorbs it and exhales oxygen.

The use of argon is unknown, nor is the function of the other air constituents well defined.

Air contains a certain amount of water in the form of aqueous vapor. The amount depends upon the temperature of the air. The higher the temperature, the more vapor the air contains. At 59° F. a cubic foot of air holds 6 grains of vapor; at 86° F. it will hold 12 grains of vapor.

When a given amount of air contains all the vapor it can possibly absorb, it is said to have reached "dew point;" the excess of moisture then condenses and is deposited upon adjacent surfaces.

Absolute Humidity is the amount of water in a given air volume. *Relative Humidity* is the amount of vapor in the air at a given temperature and the degree of its approach to saturation. A relative humidity of 60 means that at a given temperature the air holds but 60 per cent of the moisture which it is capable of absorbing at the same temperature.

Impurities in Air. Air is very seldom free from certain constituents besides those already mentioned. When air contains certain matter which is foreign to it, we regard the foreign constituents as impurities.

These impurities are usually mixed with the air by the action of winds and gravitation, which bring into the air various gases, suspended matter, etc.

The impurities in air are, according to their substance and character, as follows: Mineral, Vegetable, Animal, Bacteria, and Gases.

The mineral substances found in the air are particles of soil, such as silica, sand, chalk, iron, lead, arsenic, zinc, copper, etc.

The vegetable substances are carbon, fibres and cells, starch, grains, cotton, moulds, fungi, pollen, etc.

The animal substances are either the débris from the various living and dead animals, or the microscopic animalculi suspended in the air. The following are some of the animal particles found in air: wool, silk fibres, human hair, epithelial cells, fragments of insects, pus cells, molecular débris, and the various micro-organisms.

The bacteria in the air are either saprophytic or pathogenic, and their number varies from 0 in pure mountain air to 79,000 per cubic metre in the air of Paris.

The gaseous impurities of the air are the various compounds of carbon (carbon monoxide and dioxide), of hydrogen (sulphuretted and carburetted), of nitrogen (ammonia, ammonia acetate and sulphide, and nitrous and nitric acids), of sulphur, etc.

Impurities According to their Source. According to their source the impurities in the air are:

Impurities due to animal beings.

Impurities due to combustion.

Impurities due to various trades.

Impurities Due to the Presence of Animal Beings. The presence of human and other animal beings in confined air changes considerably the conditions of the air; the amount of oxygen is greatly reduced, and the amount of carbonic acid greatly increased on account of the absorption of oxygen by the blood and the increased amount of CO_2 in the expired air. The amount of moisture is much increased owing to the exhalations from the lungs and skin. The temperature is also increased. There is also added to the air the organic matter which is said to be exhaled from the body.

The decrease in the amount of oxygen is not very serious, and has very little effect upon the quality of the air. The increase of carbonic acid is usually very slight and very seldom exceeds 20 or 25 per 10,000 volumes. The increase of CO_2 was formerly thought to be the main cause of the bad effects of vitiated air. It is doubtful, however, whether the ordinary increase of CO_2 in the air is of much consequence, as CO_2 becomes toxic only when its amount in the air is not less than 10 per cent. Increase of moisture adds to the relative humidity of the air, which causes discomfort when it exceeds 80 or 85 degrees. Serious discomfort is also caused by the increase in temperature in overcrowded rooms.

Opinions differ as to the effects of organic matter in the air of overcrowded rooms. Experiments have shown that it is poisonous when injected in concentrated form into the blood. It is claimed by some that the injurious effects of badly ventilated rooms are due to this organic matter in the air.

Combustion is also a very important source of air

vitiation. The products of coal and wood combustion are carbon monoxide and dioxide, CO and CO_2, various sulphur compounds, and a large quantity of soot and tarry matter. Illumination by oil, candles, gas, etc., is also a source of various impurities. Every cubic foot of gas burned per hour vitiates as much air as would be rendered impure by one individual. Electric light is the only illuminant that does not add impurities to the air.

In certain *trades* a large amount of dust and also of various chemical substances and gases are produced which render the air in and about the trade-places impure.

Influence of Air on Health. That the air, without which we cannot live more than a few minutes, has a great influence on the health of man, is self-evident. The physical condition of the air, the temperature, pressure, humidity, motion, relative content of one or the other of its constituents, the degree of vitiation, and the impurities in the air, all have a marked influence on the health, life, and longevity of man.

Diseases Due to Impure Air. Impure air has been held to be the cause of all the ills to which human beings are heir. There is no doubt that a constant sojourn in badly ventilated, overcrowded rooms with foul vitiated air has a debilitating and detrimental influence upon the human body. It reduces vital resistance, decreases metabolism, causes anæmia, headaches, and loss of appetite, and predisposes the person to certain respiratory and general diseases.

As to the infectious diseases, Dr. Chapin thinks that, "There is no clinical evidence that common diseases are air-borne. Animal experimentation indicates that

tuberculosis and anthrax may be air-borne." Dr. Chapin adds:

"While it is not possible at present to state with exactness the part played by aerial infection in the transmission of the different infectious diseases, we are by the evidence forced to the conclusion that the current ideas in regard to the importance of infection by air are unwarranted. Without denying the possibility of such infection, it may be fairly affirmed that there is no evidence that it is an appreciable factor in the maintenance of most of our common diseases."

CHAPTER III

VENTILATION

Definition. The air within an uninhabited room does not differ from that without. If the room is occupied by one or more individuals, however, then the air in the room soon deteriorates, until the impurities therein reach a degree incompatible with health. This is due to the fact that with each breath a certain quantity of CO_2, of organic impurities, and aqueous vapor is exhaled. These products of respiration soon surcharge the air until it is rendered impure and unfit for breathing. In order to purify the air in such a room, and make life possible, it is necessary to change the air by withdrawing the impure, and substituting pure air from the outside. This is *ventilation.*

Ventilation, therefore, is the maintenance of the air in a confined space in a condition conducive to health; in other words, "ventilation is the replacing of the impure air in a confined space by pure air from the outside."

Quantity of Air Required. What do we regard as impure air? What is the index of impurity? How much air is required to render pure an air in a given space, in a given time, for a given number of people? How often can the change be safely made, and how? These are the problems of ventilation.

Impure Air. There is still much controversy as to what air must be regarded as so impure as to be unfit for breathing purposes. Undoubtedly, the main factors of impurity to be considered are the following:

(1) the decrease of oxygen;
(2) the increase of CO_2;
(3) the increase in moisture;
(4) the increase in temperature;
(5) the presence of organic odors and organic matter;
(6) the presence of accidental impurities.

It is of great importance in estimating the purity of air to know whether these elements of impurity are due to the presence of human and animal beings within the room, or to other causes. An increase of CO_2, due to combustion or to other causes, even a large increase to one or more per cent in the constituency of the air, is a minor consideration.

An increase of temperature, however, to above 80° F. or of humidity to above 70 degrees is of much importance when due to overcrowding. It is probable that the degree of the impurity of the air depends not so much upon one or two of the conditions mentioned, but rather upon the combination of all these conditions when they are due to the presence of human beings in the room or to the products of respiration.

An Index of Impurities. Owing to the difficulty of establishing a standard of the impurities in the air, it is very difficult to give a definite index by which these impurities may be measured and determined. The feeling of closeness in the air of overcrowded

rooms, the feeling that the air is close, or very close and foul, is but a subjective indication which may be felt only by persons coming from the fresh air who soon lose the feeling after they have remained in an overcrowded room for some time.

Until very recently the CO_2 in excess of 3 or 4 volumes per 10,000, was regarded as the only reliable index of air impurity. Pettenkoffer, DeChaumont, and others have taught that we must regard the air in a room in which human beings are present as impure when CO_2 exceeds 6 per 10,000 in volume. This has been regarded as a valuable index of air impurity and this test is still used to determine the character of the air in houses, schools, etc.

As has been noted, large quantities of CO_2 may be breathed with comparative impunity when they are not due to the products of respiration and an increase of temperature, and the presence of organic emanations from overcrowding are of much more importance in the determination of the purity of air than the mere quantity of CO_2.

It is very important to make tests of the amount of dust and the number and kind of bacteria found in the dust of the air of rooms, and it is imperative when determining the character of the impurities of the air in a room to measure all the various factors, such as the increase of CO_2, the increase of relative humidity, the temperature, and the amount and character of the dust and bacteria.

Quantity of Air Needed. The quantity of air needed for a human being in a closed room has been calculated on the basis of the CO_2 test, taking 6 volumes

as the maximum of CO_2 allowable in 10,000 volumes of air, to be 3000 cubic feet an hour.

In determining the cubic space needed, the height of the room as well as the floor space must be taken into consideration. As a rule the height of a room ought to be in proportion to the floor space, and in ordinary rooms should not exceed 14 feet, as a height beyond that is of very little advantage.

Forces of Ventilation. We now come to the question of the various modes by which change in the air of a room is possible. This change is made possible principally because air is a gas, and as such possesses the properties of all gases. These properties, as has been already noted, are diffusion, motion, and gravity, and it is due to these properties of air as a gas, as well as to the fact that our houses are constructed of porous materials and also contain numerous apertures and crevices that natural ventilation is possible.

These properties of air, which render ventilation possible, are also called forces of ventilation. They act as agents and means of ventilation.

There is a constant diffusion of gases taking place in the air; this diffusion takes place even through stone and through brick walls. The more porous the material of which the building is constructed, the more readily does diffusion take place. Dampness, plastering, painting, and papering of walls diminish diffusion, however.

The second force in ventilation is the motion of air, or wind. This is the most powerful agent of ventilation, for even a slight, imperceptible wind travelling about two miles an hour is capable, when the windows and doors of a room are open, of changing the air of

a room 528 times in one hour. Air passes also through brick and stone walls. The objections to winds as a sole mode of ventilation are their inconstancy and irregularity. When the wind is very slight, its ventilating influence is very small; on the other hand, when the wind is strong, it cannot be utilized as a means of ventilation on account of the air-currents being too strong and capable of exerting deleterious effects on health.

The third, the most constant and reliable, and, in fact, principal agent of ventilation, is the specific gravity of the air, and the variations in its gravity and consequent pressure which are results of the variations in temperature, humidity, etc. Whenever air is warmer in one place than in another, the warmer air being lighter and the colder air outside being heavier, the latter exerts pressure upon the air in the room, causing the lighter air in the room to escape and be displaced by the heavier air from the outside, thus changing the air in the room. This mode of ventilation is a constant one, as the very presence of living beings in the room warms the air in it, thus causing a difference from the outside air and effecting a change of air from the outside to the inside of the room.

Methods of Ventilation. In most text-books on hygiene, two methods of ventilation are spoken of: the natural and the artificial. By the natural method of ventilation is meant only that ventilation which is carried on by the diffusion and motion of the air through the porous building materials of the house, by the unforced aspiration and propulsion of the air

through these materials. By artificial ventilation is usually meant all ventilation which is carried on through artificial openings or by artificial means. In these are included windows, doors, transoms, space openings, as well as special means of drawing air out of a room and of propelling air into it. It seems to me that the terms natural and artificial are not the proper terms to be used and that systems of ventilation should be classified more logically according to the actual methods employed in changing the air.

Ventilation Through Porous Building Materials. By means of diffusion as well as by the action of the air in motion, a certain amount of air is able to penetrate into the house and the rooms of the house through the material of the walls, ceilings, and floors. The amount of air which may come into the room or leave the room through the pores in these materials is very limited at all times and is still more limited when the surfaces within the room are painted or covered with air-tight paints or when the walls, ceilings, etc., are damp and filled with moisture which effectually prevents the entrance of air through the pores.

The amount of change of air which is possible by these means is very limited and practically negligible and cannot be counted upon as a reliable method of ventilation.

Ventilation Through Windows, Doors, Transoms and other Openings. There are a number of openings made in all houses. Some of these openings are due to faulty construction, others are made for the purpose of egress and entrance, while others are made

for the purpose of allowing light into the rooms. These openings, however, although not made for the purpose of ventilation usually serve for this purpose and constitute an important means of ventilation in houses and rooms. A large amount of air escapes from and enters rooms through closed windows and doors, through crevices and openings in these, and especially through the occasional opening of the windows and doors for various purposes. The windows especially are a good means of ventilation when properly used, when they are kept open or are opened from time to time.

Ventilation Through Special Openings and Devices. Not relying upon these for ventilation, however, a number of additional devices are often installed for the better exchange of air between the outside and inside of rooms. Most of the devices consist in openings called inlets or outlets. These openings are put in the window panes, in the window frames, in the walls, in the ceilings, or in the floors.

Openings are often made in the window pane itself by cutting out a circular piece from the upper part of the pane and inserting in it a piece of perforated sheet metal. Another device which is used is the raising of the lower sash from 4 to 6 inches and the insertion in the opening of a board or metal sheet. This leaves an opening between the lower and upper sashes where they meet, and allows the air to come in upward through the opening. Some window panes are constructed on pivots so that they may be readily opened and thus serve as a means of ventilation. There are also a number of devices consisting of boxes, or

perforated boards, or sheet metal tubes, which are inserted under the sashes or in the sashes of the windows. There are also innumerable devices consisting of various tubes and boxes which are inserted in the wall either in the lower or in the upper part of the room, the openings being provided with shutters easily opened or closed. There are also a number of devices which may be constructed in the ceilings of rooms. These consist either of hollow beams opened at certain places in the room or of tubes open at the ceiling and leading outward to the outside air.

Ventilation by Means of Heating. An important method of ventilation is by means of various apparata which are used for heating purposes and for the warming of rooms. The very fact of increasing the temperature of the air in a room greatly aids ventilation by increasing the difference between the temperature of the air outside and the temperature inside and thus hastening the exchange of air. The chimney openings and chimney flues and shafts which are used in connection with heating, are also valuable means of ventilation, in fact, they act as outlets for the air in the room, especially when the air in these shafts, etc., is heated, or, by aspiration, when the winds pass over the chimney openings on the tops of the roofs. This aspiration is very often aided by specially constructed cowls.

Ventilation by Fans. Mechanically driven fans are often used for ventilating purposes. When these fans are placed within the room they do not change the air of the room, nor do they increase the amount of outside air or decrease the amount of foul air

in the room, but they aid greatly in cooling the room by their motion and by the more rapid evaporation of moisture which they promote in the room. These fans, however, may be a very valuable means of ventilation if they are placed in openings either in the walls or the windows and if the blades are so constructed as either to drive air out of the room with each revolution or to propel air from outside into the room by the same means.

Central Ventilation by Mechanical Means. The most valuable methods of ventilation are those by which the air is drawn out of the room or by which air is introduced into the room through openings and tubes leading to centrally located mechanical apparata. Such ventilation is accomplished either by aspirating the air from the building, that is, by the vacuum or extraction method, or by forcing into the building air from without, the plenum or propulsion method.

The advantages of mechanical ventilation are the constancy of the exchange of air which it secures, its independence of any other means of ventilation, the perfect control of the velocity and the volume of the air supplied, and the accurate regulation of the temperature, moisture, and impurity of the incoming air, which it makes possible. The combined vacuum and plenum method is preferable to either the vacuum or plenum method alone, as by the combined method the impure air is removed while the air from outside is introduced into the room.

Mechanical ventilation requires inlet and outlet openings in the room, and ducts and tubes leading

out of the building from the inlets and outlets. It also requires fans and motors to operate the propulsion or exhaustion fans.

The incoming air may be moistened, cooled, and warmed, as well as filtered in the incoming tubes by special devices. The velocity of the incoming air may be measured by anemometers, the temperature controlled by thermostats, and the humidity controlled by humidostats.

Parkes and Kenwood summarize the essential and practical points of ventilation as follows:

"1. When air is heated, it expands and tends to rise; when air is cooled, it contracts and tends to fall.

"2. Cold air tends to enter a room and to move about very much as water would; and this holds true so long as the temperature of the fresh air remains lower than that in the room.

"3. The extent of inlet provision is not quite of the same importance as that for the exit of foul air; for if foul air is extracted in sufficient quantities, fresh air will enter somehow to replace it, as by skirtings, crevices in doors or windows, or even through brickwork in walls.

"4. While the inlet provision for fresh air should average 24 square inches for each individual, several small inlets not too near each other are preferable to one large one; and the provision of inlet areas somewhat larger than those of exit tends to minimize draughts.

"5. Inlets should be as low in the room as possible —i.e., just above the floor (so as not to raise the dust)—

if the outside air is warm or has been warmed prior to entry; but at a height of 5 feet or more if the outside air is cold; otherwise unpleasant draughts are experienced. As a further protection against unpleasant draughts when cold air is admitted, the incoming air should be directed upward; while hot air, since it tends to rise, should be directed downward.

"6. If possible, outlets should be so placed that vitiated air is drawn out before mixing with the general air of the room.

"7. The tendency of fresh air to take a direct course to the outlets must be overcome by judicious selection of the positions of inlets and outlets.

"8. Methods of ventilation devised to ventilate *crowded* premises are generally inefficient unless the incoming air can be warmed in winter to about 60° F.; for efficient ventilation by cold air cannot be tolerated, and there is a great tendency among workers to close all ventilating inlets.

"9. With less than 250 cubic feet of space for each person, ventilation can never be satisfactory without the aid of mechanical force.

"10. The source of incoming air should be considered. It should not be borrowed from adjoining rooms, but taken directly from the outside. One great advantage of the more expensive mechanical system of ventilation is the fact that sufficient air can always be obtained from a source that is known and selected.

"11. Ventilation dependent on the extraction of foul air is more convenient and satisfactory than that in which propulsion is mainly relied upon; but the purity of the air is not provided for so easily.

"12. Warmed air forced into a room should be raised only to a temperature sufficient to prevent a feeling of cold (about 60° F.). More highly heated air is often felt to be over-dry and unpleasant."

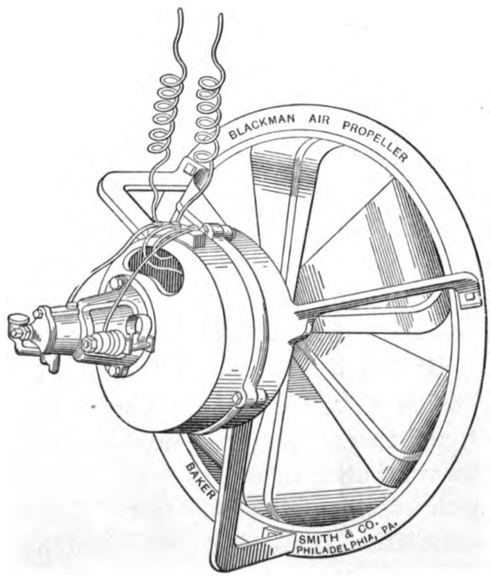

FIG. 3.

CHAPTER IV

WARMING

Ventilation and Heating. The subject of the heating of our rooms and houses is very closely allied to that of ventilation, not only because both are a special necessity at the same time of the year, but also because we cannot heat a room without at the same time having to ventilate it, by providing an egress for the products of combustion and by introducing fresh air to replace the air which has been vitiated.

Need of Heating. In a large part of the country, and during the greater period of the year, some mode of heating rooms artificially is absolutely necessary to comfort and health. The temperature of the body is 98 to 99° F., and there is a constant radiation of heat due to the cooling of the body surface. If the external temperature is very much below that of the body, and if the low temperature is prolonged, the radiation of heat from the body is too rapid, and colds, pneumonia, etc., result. The temperature essential for the individual varies according to age, constitution, health, environment, occupation, etc. A child, a sick person, or one at rest requires a higher temperature relatively than a healthy adult at work. The room-temperature most conducive to the health of the average person is the mean from 65 to 75° F.

The Three Methods of Heating. The heat of a room may be obtained *directly* either from the rays of the sun or the process of combustion. Heat so received, from open fires and grates for example, is called *radiant* heat.

Or, the heating of places may be accomplished by conducting heat through certain materials, like brick walls, tile, stone, or iron. Heat so conducted, called *conductive* heat, is afforded by stoves, etc.

Or, the heat is *conveyed* by means of air, water, or steam from one place to another, as in the hot-water, hot-air, and steam systems of heating; this we call *convected* heat.

There is no strict line of demarcation between the three methods of heating, for it is possible that radiant heat may be conductive and convective at the same time—as is the case in the Galton fire-place, etc.

Materials of Combustion. The materials of combustion are air, wood, coal, oil, and gas. Air is indispensable, for, without oxygen, there can be no combustion. Wood is used in many places, but is too bulky and expensive. Oil is rarely used as a material for combustion, its principal use being for illumination. Coal is the best and cheapest material for combustion. The chief objection against its use is the production of smoke, soot, and of various gases, as CO, CO_2, etc. Gas is a very good, in fact, the best material for heating, especially if, when used, it is connected with chimneys; otherwise it is objectionable, as it burns up too much air and vitiates the atmosphere, the products of combustion being deleterious; it is also quite expensive. The ideal means of heating is electricity.

Chimneys. All the materials used for combustion yield products more or less injurious to health. Every system of heating houses artificially must therefore not only have means of introducing fresh air to aid in the burning up of materials, but also outlets for the vitiated, warmed air, which is charged with the products of combustion. These outlets are provided by chimneys. Chimneys are hollow tubes or shafts built of brick and lined with earthen pipes, or other material. These tubes begin at the lowest fire-place or fire-connection, and are carried several feet above the roof. The thickness of a chimney is from 4 to 9 inches; the shape square, rectangular, or preferably circular. The diameter of the chimney depends upon the size of the house, the number of fire-connections, etc. It should be neither too small nor too large. Square chimneys should be 12 to 16 inches square; circular ones from 6 to 8 inches in diameter for each fire-connection. The chimney consists of a *shaft*, or vertical tube, and *cowls* placed over chimneys on the roof to prevent down-draughts and the falling in of foreign bodies. The part of the chimney which opens into the fire-place is called the *throat.*

Smoky Chimneys. A very frequent cause of complaint in a great many houses is the so-called "smoky chimney," from which smoke and coal-gas escape into the living rooms. The principal causes of nuisance on this account are:

(1) A too wide or a too narrow diameter of the shafts. A shaft which is too narrow does not let all the smoke escape; one which is too wide lets the smoke rise part way only, then when the smoke meets

a counter-current of cold air it is liable to be forced back into the rooms.

(2) The throat of the chimney may be too wide, and by holding cold air, may prevent the warming of the air in the chimneys and the consequent draught upwards.

(3) The cowls may be too low or too tight, preventing the escape of the smoke.

(4) The brickwork of the chimney may be loose, badly constructed, or broken into by nails, etc., thus allowing smoke to escape.

(5) The supply of air may be deficient, as when all the doors and windows are tightly closed.

(6) The chimney may be obstructed by soot or some foreign material.

(7) The wind above the house may be so strong that its pressure will cause the smoke from the chimney to be forced back.

(8) If two chimneys rise together from the same house, and one is shorter than the other, the draught of the longer chimney may cause an inversion of the current of air in the lower chimney.

(9) Wet fuel when used will cause smoke by its incomplete combustion.

(10) A chimney without a fire may suck down the smoke from a neighboring chimney; or, if two fireplaces in different rooms are connected with the same chimney, the smoke from one room may be drawn into the other.

Methods of Heating. Open Fire-places and Grates. Open fire-places and fires in grates connected with chimneys, and using coal, wood, or gas, are very com-

fortable; nevertheless there are weighty objections to them. In the first place, only a very small part of the heat of the material burned is utilized, about 12 per cent being radiated into the room, the rest going up the chimney. Secondly, the heat of grates and fire-places is only local, not reaching far beyond the fire itself, warming only one side of the people near it and a small part of the room. Thirdly, the burning of open fires necessitates a great supply of air, and causes powerful draughts.

The open fire-place can, however, be much improved by surrounding its back and sides with an air-space, in which air can be warmed and from which air may be conveyed into the upper part of the room. If then a special air-inlet is provided to supply the fire with fresh air to be warmed, we get a very valuable means of heating. These features are embodied in the Franklin and Galton grates. A great many other grates have been suggested, and put on the market. The principal objection to them, however, is their complexity and expense, which makes their use a luxury not attainable by the masses.

Stoves. Stoves are closed receptacles in which fuel is burned; the heat produced is radiated toward the persons, etc., near them, also it is conducted through the iron or other materials of which the stoves are made to surrounding objects. Seventy-five per cent of the fuel burned in stoves is utilized. Stoves may be of brick or tile, cast or wrought iron.

Brick stoves, and stoves made of tile, are extensively used in some European countries, such as Russia, Germany, and Sweden; they are made of slow-conducting

material, and give a very equable, efficient, and inexpensive heat, although their ventilating power is very small.

Iron is used extensively because it is a very good conductor of heat, and can be made into very convenient forms. Iron stoves, however, often become superheated, dry up, and sometimes burn the air

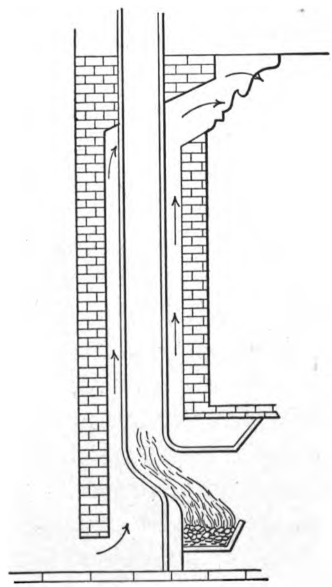

FIG. 11.—GALTON GRATE. (TRACY.)

around them, producing certain deleterious gases during combustion. When the fire is confined in a clay firebox, and the stove is not overheated, a good supply of fresh air being provided and a vessel of water placed on the stove to reduce the dryness of the air, iron stoves are quite efficient.

Hot-air Warming. In small houses the warming of the various rooms and halls can be accomplished by placing the stove or furnace in the cellar, heating a

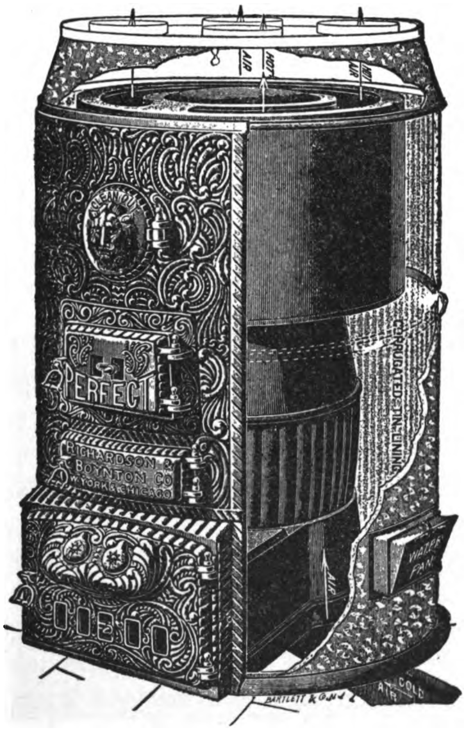

FIG. 5.—HOT-AIR FURNACE.

large quantity of air and conveying it through proper tubes to the rooms and places to be warmed. The points to be observed in a proper and efficient hot-air heating system are the following:

(1) The furnace must be of a proper size in proportion to the area of space to be warmed. (2) The joints

and parts of the furnace must be gas-tight. (3) The furnace should be placed on the cold side of the house, and provision made to prevent cellar-air from being drawn up into the cold-air box of the furnace. (4) The air for the supply of the furnace must be gotten from outside, and the source must be pure, above the ground-level, and free from contamination of any kind. (5) The cold-air box and ducts must be clean, protected against the entrance of vermin, etc., and easily cleaned. (6) The air should not be overheated. (7) The hot-air flues or tubes must be short, direct, circular, and covered with asbestos or some other non-conducting material.

Hot-water System. The principles of hot-water heating are very simple. Given a circuit of pipes filled with water, on heating the lower part of the circuit, the water, becoming warmer, will rise, circulate, and heat the pipes in which it is contained, thus warming the air in contact with the pipes. The lower part of the circuit of pipe begins in the furnace or heater; the other parts of the circuit are conducted through the various rooms and halls throughout the house to the uppermost story. The pipes need not be straight all through; hence, to secure a larger area for heating, they are convoluted within the furnace, and also in the rooms, where the convoluted pipes are called *radiators*. The water may be warmed by the low- or high-pressure system; in the latter, pipes of small diameter may be employed, while in the former pipes of a large diameter will be required. The character, etc., of the boilers, furnace, pipes, etc., cannot be gone into here.

Steam-heating System. The principle of steam heating does not differ from that of the hot-water system. The on'y difference is that the pressure is greater and that steam is employed instead of water. The steam gives a greater degree of heat, but the pipes must be stronger and able to withstand the pressure. There are also combinations of steam and hot-water heating. Either steam or hot-water heating is the best means of warming large houses, and, if the apparatus is properly constructed and cared for, quite healthful.

A steam heating plant needs expert attendance, and a large consumption of coal, and cannot well be regulated so as to give constant heat. As soon as the heat in the boilers is reduced below the production of vapor; the pipes and radiators suddenly cool off. There is, therefore, usually a marked difference between the day and the night temperatures of steam-heated rooms. An annoying concomitant of a steam heating system is the noise and hammering within the pipes due to the steam meeting with the condensed water from cooled off radiators. This "water hammer" is met with very often.

CHAPTER V

WATER

Composition. Water is a compound of two elements: Hydrogen and Oxygen, united in the proportion of 2 volumes of the former to 1 of the latter; its chemical formula is H_2O.

Quantity Required. Owing to the many uses to which water is put, a large quantity is needed. The quantity varies according to the people and their degree of civilization, according to place, supply, etc. The average quantity of water needed for all purposes has been estimated to be about 50 gallons per head per day. Most of the cities furnish a larger supply, however.

Characteristics and Quality of Water. Water for drinking purposes must be clear, colorless, and without taste or odor; it should be aerated and free from impurities. Water is a powerful solvent, and therefore, in a state of nature, contains a great number of elements, compounds, and gases in solution as well as in suspension. The taste of water depends upon its source, its character, the substances and gases it contains, etc. When water contains a large quantity of calcium bicarbonate and magnesium salts, it is called *hard*. Soft water is better than hard for washing and cooking purposes, as well as for the production of

steam, hard water causing much trouble by forming incrustations within pipes and boilers. Not every palatable water is wholesome, as sometimes a palatable, sparkling water is due to excess of CO_2 produced by pollution with organic matter. Rain-water, when uncontaminated, is the purest and most wholesome, but it is not very palatable owing to the fact that it is not aerated.

Source. All water is derived primarily from the precipitation of aqueous vapor in the form of rain, snow, and dew.

The sources of the water supply are:

(1) Rain—collected immediately after falling, and stored for later use.

(2) Surface-water—found in lakes, rivers, and ponds.

(3) Ground-water—obtained from springs and wells.

According to the Report of the River-Pollution Commission, the following waters are:

Wholesome.......	Spring-water,	very palatable.
	Deep well-water,	
	Upland surface-water,	moderately palatable.
Suspicious........	Stored rain-water,	
	Surface-water from cultivated land,	palatable
	River-water contaminated with sewage	
	Shallow well-water,	

Impurities. Absolutely pure water can only be found in the laboratory in the form of distilled water, immediately after condensation; for water, being a powerful solvent, takes up foreign materials and gases with which it comes in contact. Rain is the purest water found in nature, but in its transit through the air it takes up suspended impurities, and when it reaches the ground is already contaminated by them.

The impurities found in water are classified according to their character, as mineral, vegetable, animal, bacterial, and gaseous; or, according to their source, the character of the soils, and the contamination of the water due to the methods of its collection, storage, distribution, etc.

Pollution. Owing to the fact that water takes up most inorganic and organic matters, it is often contaminated by various poisonous materials, metals, organic impurities, and pathogenic bacteria with which it comes in contact on passing from its various sources, through the soil, surface-air, ground-water, etc. The sources of water-supply, especially within the soil, also on the surface, as in rivers and lakes, are liable to be contaminated by sewage, refuse, bacteria, and other impurities, and the water to take up any or all of these impurities.

Influence on Health. Next to air, water is most indispensable to life and health; and the lack of water, or a supply of water contaminated by impurities, naturally exerts a great influence on health. A deficient supply for drinking purposes will cause failing health, and a lack of water for body cleansing and flushing purposes will impair the health and predispose to various diseases. The impurities contained in water are capable of producing various diseases, according to the character and the quantity of the impurity.

Water and Diseases. The physical impurities, such as the débris of vegetable, animal, and mineral matter, which are often found in water, may be dangerous to health, because of the disturbances they cause in the digestive tract. The degree of injuriousness depends

upon the quantity, composition, etc., of the impurities The chemical impurities are found in the form of dissolved metals or gases, and include sulphur, lead, arsenic, and other toxic elements in greater or less quantities. The ingestion of water containing such substances may become dangerous to health.

Certain parasites and their ova are also found in water. Among these are the ova of tape-worms, round-worms, and especially of hook-worms. The terrible scourge of "hook-worm disease" in the Southern States is undoubtedly transmitted by means of water containing the ova.

There is no doubt whatever that typhoid, cholera, and dysentery have been, and are frequently caused by the drinking of water containing the germs of these infectious diseases. Indeed, these have been properly named the "water borne diseases." The presence of typhoid, cholera, and dysentery germs in water as well as the direct transmission of such diseases through the agency of water has been clearly demonstrated. There are also abundant data which show a marked decrease in the prevalence of such diseases whenever precautions for the prevention of contamination or for purification of contaminated water are taken.

CHAPTER VI

WATER-SUPPLY

Water-supply. Wherever there is a large number of people in one place, the quantity of water needed for the use of the population is very great, and a supply of sufficient quantity and quality becomes a sanitary problem of great importance. The importance of this problem was recognized very early in the history of man; we find in many ancient lands quite successful attempts to supply water on a large scale. In Egypt artificial lakes were made to provide an adequate water-supply in places where the natural supply from the Nile was insufficient. Remains of gigantic water-basins of marvellous construction have been found in Peru and Mexico. In Ceylon may be found the remains of a great tank or artificial lake, 40 miles in circumference. It was in ancient Rome, however, that the municipal supply of water reached the zenith of its development. In the year 624 B.C. King Ancus Marcius began the first great aqueduct which supplied Rome with pure water drawn from a distant mountain. At the end of the first century A.D. we find in Rome 14 aqueducts supplying 375 millions of gallons, or about 300 gallons per head per diem.

During the middle ages all sanitary measures, including the municipal supply of water, were neglected;

and, coming down to more recent times, we find that in the United States, at the beginning of the nineteenth century, only 17 water-works were in existence. During the past century, however, great progress has been made in this as well as in other sanitary matters; and at present we find in the United States nearly 4000 water-works, most of them owned by municipalities.

Sources of Water-supply. The sources of the water-supply are, as we have seen in the last chapter: (1) Rain, (2) surface-water, and (3) subsurface-water.

Rain-water. The supply of rain-water is uncertain, variable in quantity, and unreliable in quality.

The quality of rain-water, apart from its lack of aeration, is good, but only a small part of the water needed can be conveniently collected for immediate use; and in order to make provision for later use various receptacles have to be employed for the storage of rain-water and for its distribution. The receptacles employed for the storage, etc., of rain-water are liable to contamination. As a rule, little surety can be had of supplying a large number of people with rain-water.

Surface-water. Surface-water is rain collected on the surface of the ground in the form of ponds, lakes, and rivers, which serve as natural reservoirs and storage-tanks for the collection of fresh water. The water from these sources is easy to obtain, and in unpopulated districts is, as a rule, very pure and fit for drinking purposes. The character of these waters depends, however, upon the nature of the soil in which they are located, and upon degree of their contamination by sewage,

refuse, and the organic impurities drained into the watercourses. The proximity of dwellings, towns, factories, etc., greatly influences the character and purity of the natural water-supply.

Subsurface-waters. The water gained from underground sources is that found in springs and wells.

Springs are natural upwellings of subsoil-water, and are found in very many regions. The character of spring-water varies according to the source, temperature, and physical character of the soils through which the water passes. There are iron, sulphur, salt, and other springs, according to the minerals they contain; there are also springs the waters of which are of high temperature. But in the great majority of springs the water is cool, free from impurities, and wholesome.

Springs, however, should be protected from contamination by preventing sewage and surface drainage from getting into them, by fencing them in, and by properly shading and covering them.

Wells are holes bored in the ground to certain levels at which water is found. There are numerous kinds of wells, whether shallow or deep. Some wells are dug, others bored, others punched, others driven, and yet others sunk by the jet process. The character and the type of the well depend upon the depth of the water in the ground and upon the character of the ground itself. The most important problem in constructing a well is the prevention of contamination. The well must be lined with impermeable material, otherwise polluting matter will enter through the crevices and the walls. The wall should also be covered

so as to prevent impurities from being thrown into it, and should be fenced around so as to prevent animals from getting into it.

The main contamination of wells is through the seepage of surface drainage. This must be prevented by locating stables, privies, etc., at great distances from the wells, and by paving, grating, and draining the ground around wells. There is really no "safe distance" factor in regard to the location of stables, privies, etc. near wells. There are a number of factors which enter into consideration. At any rate, no source of pollution should be tolerated within 100 feet of a well; a distance of 150 feet and more is preferable. It is best to locate the well at places where there is no possibility whatever of contamination.

Storage, Collection, and Distribution. Whenever a large quantity of water is required for future use, the water should be collected and stored in receptacles made for the purpose. The collection, storage, and distribution of water is an engineering problem which cannot be gone into here. Storage-tanks and reservoirs are constructed of brick, stone, or cement, if large, and of iron or wood, if small. All storage-vessels are liable to be contaminated, hence means must be provided to protect and cleanse them.

When the source of the water-supply is far from the place of delivery, means have to be provided for conveying the water into the towns, etc., where it is to be used; this is done by stone and brick, also iron and lead conduits and pipes, through which the water passes. There are some objections to iron as well as to lead pipes. Iron becomes rusty in time, and lead is prone

to impart to the water some of its metal, and thus may cause lead-poisoning. Glazed iron pipes and pipes coated with various non-absorbant substances have been devised to meet these objections.

Purification of Water. The large number of impurities, some of them very dangerous to the health and life of the consumers, which are commonly found in drinking water, render the problem of water purification an important one from a sanitary standpoint. Water purification should be twofold—public and private.

Whenever the water supply is collective, public and on a large scale, the community at large should provide for proper water purification. Whether there is a public water purification plant or not, every individual household should provide some means of local water purification.

Methods of Domestic Water Purification. Water may be purified for domestic use by sedimentation, boiling, distillation, chemical means, and by filtration.

Sedimentation. Water may be freed from coarser particles of impurity like sand and dirt by letting it stand in a vessel for from twelve to twenty-four hours. This may also free the water from such organic matter and impurities as are held in suspension, without, however, clearing it of the impurities held in solution.

Boiling. All living organic matter and germs are destroyed by raising the temperature of water to the boiling point and keeping it at that temperature for a certain time. This is the cheapest and most available method of purification and is also the most efficient. The objection against boiled water is the insipid taste which results from the expulsion of air

and carbon dioxide by the process of boiling. The pleasant taste of the water may be restored to boiled water by aeration, or by charging it with carbonic acid gas.

Distillation. This is the surest and best means of removing all impurities. It kills all germs, and all of the spores, and gives an absolutely pure water, which when aerated, or charged with carbon dioxide is very palatable in addition to being pure. The objection to the distillation of water for domestic purposes lies in the necessity for a proper apparatus; but the time seems to be approaching when every house will be furnished with water distilling apparatus just as it is at present furnished with a cooking range and hot water boiler. The apparatus to be of value should be simple in construction, easily operated, durable, strong, and readily cleansible. It should furnish an adequate supply of water for all domestic purposes with little trouble and at small cost. Such an ideal apparatus has as yet not been invented, but there are a number of devices which approximate it and may safely be used.

Chemical Means. The settling of turbid water may be hastened by the addition of a few grains of alum (not more than six grains to the gallon). The addition of small quantities of potassium permanganate has a destructive effect upon organic matter. Addition of tea leaves, and other vegetables containing tannin is said to reduce the danger from organic impurities, but this is problematic. Other chemicals, like borax and boracic acid, copper sulphate, etc., have been advocated but when used in too small

quantities they are of little or no value; when used in larger quantities they may become as dangerous to health, as the impurities which they are intended to destroy.

Water Filtration. Water may be purified by filtration, i.e., by letting the water pass through some material which is capable of retaining some, or all of the impurities it contains. The value of a water filter depends upon the following factors:

(1) The character of the filtering medium and its ability to retain and remove from the water as many impurities as possible.

(2) The thoroughness and rapidity of the process.

(3) The ease with which the filtering media may be cleaned and disinfected.

(4) The simplicity, cheapness and accessibility of the filter.

It is claimed for some filters that they are able to remove all the organic impurities, as well as bacteria, from the water, but this has not been proved as yet. It is true certainly of only a very few filters upon the market, and of those, only when they are new. Whenever water is suspected of containing pathogenic bacteria dependence upon filters may become dangerous to health; and distillation is the only sure way of securing purity of drinking water.

The materials which are used for filtering water are sponges, wool, asbestos, sand, stone, porcelain, infusorial earth, spongy iron, magnetic carbide of iron, charcoal, etc. Sponges, wood materials, and asbestos cannot very well be depended upon; at best they act but mechanically, easily get dirty, and are

difficult to clean. Sand and porous stone will arrest suspended matter; they may even remove some of the organic matter. It is doubtful, however, that all organic impurities and microbes can be removed by them. Charcoal is a very good filtering medium in some respects. Animal and not wood charcoal is used. Animal charcoal is prepared from calcined crushed animal bones and may be used in block form, or in the form of a powder. Charcoal removes coloring matter and considerable organic matter from water; but does not remove all organic impurities. Charcoal used for filtering must be frequently recalcined. Unglazed porcelain is used for filtering purposes and is quite effective in removing water impurities, provided the filtering porcelain is frequently cleansed, as the impurities are apt to clog it up.

Infusorial earth is used in the Berkefeld filter. It is pressed in the form of hollow tubes. The water passes under pressure through the fine pores of the filter and gains access to the tap. It is claimed for this filter, that, when new, it will remove all organic matter and bacteria from the water. The filter is made in various forms and sizes and may be attached to the house sink faucet. The filtering tube must be removed frequently, sometimes more than once a day, and the dirt accumulating upon the surfaces washed off, otherwise the filtering process becomes slower and slower and stops when the pores of the tubes are clogged.

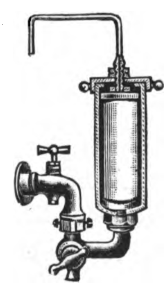

FIG. 6,
Berkefeld Filter.

CHAPTER VII

DISPOSAL OF SEWAGE

Waste Products. There are a large number of waste products in human and social economy. The products of combustion, such as ashes, cinders, etc.; the products of street sweeping; the waste from houses: dust, rubbish, paper, etc.; the waste from various trades; the waste from kitchens, e.g., scraps of food, etc.; the waste water from the cleansing processes of individuals, domestic animals, clothing, etc.; and finally the excreta—urine and feces—of man and animals; all these are waste products that cannot be left undisposed of, especially in cities or wherever a large number of people congregate. All waste products are classified into three distinct groups: (1) refuse, (2) garbage, and (3) sewage.

The amount of *refuse* and *garbage* in cities is quite considerable; in Manhattan alone the dry refuse amounts to 1,000,000 tons a year, and that of garbage to 175,000 tons per year. A large percentage of the dry refuse and garbage is valuable from a commercial standpoint, and with proper facilities for collection and separation could be utilized. The disposal of refuse and garbage has not as yet been satisfactorily dealt with. The methods of waste disposal in the United States are: (1) dumping into the sea; (2) filling in

made land, or ploughing into lands; (3) cremation; and (4) reduction by various processes, the products being utilized.

Sewage. By sewage we mean various waste matter which is disposed of through sewers. Such waste matter contains the urine and feces of human beings, waste water from bath tubs, washbasins, sinks, laundry tubs, etc., and various other household waste matter.

The amount of excreta per person has been estimated (Frankland) at 3 ounces of solid and 40 ounces of fluid per day, or about 30 tons of solid and 100,000 gallons of fluid for each 1000 persons per year.

In sparsely populated districts the removal and ultimate disposal of sewage presents no difficulties; it is returned to the soil, which, as we know, is capable of purifying, disintegrating, and assimilating quite a large amount of organic matter. But when the number of inhabitants to the square mile increases, and the population becomes as dense as it is in some towns and cities, the disposal of the human waste products becomes a question of vast importance, and the proper and final, as well as immediate disposal of sewage becomes a serious sanitary problem.

It is evident that sewage must be removed in a thorough manner, otherwise it will endanger the lives and health of the people.

The dangers of sewage to health are due to:

(1) its offensive odors, which, while not always directly dangerous to health, often produce headaches, nausea, etc.;

(2) the fact that the organic matter contained in

sewage decomposes and evolves gases and other products of decomposition;

(3) that sewage may contain a large number of pathogenic bacteria (typhoid, dysentery, cholera, etc.);

(4) contamination of the soil, ground-water, and air, by the percolation of sewage through it.

The problem of sewage disposal is twofold, involving: (1) the immediate removal of sewage out of household premises, and beyond city limits; (2) the final disposition of sewage, after its removal from cities, etc.

The Final Disposal of Sewage. The chief constituents of sewage are organic matter, mineral salts, nitrogenous substances, potash, and phosphoric acid. Excreted matter before it has stood long has an acid reaction, but in twelve to twenty hours becomes alkaline, because of the free ammonia formed in it. Sewage decomposes rapidly, evolving organic and fetid matters, ammonium sulphide, sulphuretted and carburetted hydrogen, etc., besides teeming with animal and bacterial life. A great many of the substances contained in sewage are valuable as fertilizers of soil.

The systems of final sewage disposal are:

(1) the discharge of the sewage into seas, lakes and rivers;

(2) cremation;

(3) physical and chemical precipitation;

(4) intermittent filtration;

(5) land irrigation;

(6) " bacterial " treatment.

Discharge into Waters. The easiest way to dispose

of sewage is to let it flow into the sea or into some watercourse. The objections to discharging sewage into the rivers and lakes near cities, especially such lakes and rivers as supply water to the municipalities, are obvious. But as water can purify a large amount of sewage, this method is still in vogue in certain places, although it is to be hoped that it will in the near future be superseded by more proper methods. The objection against discharging sewage into the sea is due to the operation of the tides, which cause a backflow and overflow of sewage from the pipes. This backflow is prevented (1) by providing tidal flap-valves, permitting the outflow of sewage, but preventing the inflow of sea-water; (2) by discharging the sewage intermittently, only during low tide; and (3) by providing a constant outflow by means of steam-power pressure.

Cremation. Another method of getting rid of the sewage without attempting to utilize it is by cremation. The liquid portion of the sewage is allowed to drain and to run into watercourses; the more or less solid residues are collected and cremated in suitable crematories.

Precipitation. This method consists of separating the solid matters from the sewage by precipitation, or by physical or chemical processes, the liquid being allowed to drain into rivers and other waters, and the precipitated solids being utilized for various purposes. The matter is precipitated either by straining the sewage, collecting it into tanks, and letting it settle, when the liquid is drawn off and the solids remain at the bottom of the tanks, a rather unsatis-

factory method; or, by chemical processes, precipitating the sewage by chemical means, and utilizing the products of such precipitation. The chemical agents by which precipitation is accomplished are many and various; among them are lime, alum, iron perchloride, phosphates, etc.

Intermittent Filtration. Sewage may be purified mechanically and chemically by means of intermittent filtration, by passing it through filter-beds of gravel, sand, coke, cinders, or any such materials. Intermittent filtration has passed beyond the experimental stage and has been adopted by a number of cities where such a method of sewage disposal seems to answer all purposes.

Land Irrigation. In this method the organic and other useful portions of sewage are utilized to irrigate land, to improve garden and other vegetable growths by feeding the plants with the organic products of animal excretion. Flat land, with a gentle slope is best suited for irrigation. The quantity of sewage disposed of will depend on the character of the soil, its porosity, the time of the year, temperature, intermittency of irrigation, etc. The extent of the land needed for sewage disposal must be determined in each case.

Bacterial Methods. The other biological methods, or the so-called "bacterial" sewage treatment, are but modifications of the filtration and irrigation methods of sewage disposal. Properly speaking the bacterial purification of sewage is the scientific application of the knowledge gained by the study of bacterial life and its action upon sewage.

In intermittent filtration the sewage is passed through filter-beds of sand, etc., upon which filter-beds the whole burden of the purification of the sewage rests. In the bacterial methods the work of purification is divided between the septic tanks which the sewage is first let into and where it undergoes the action of the anaerobic bacteria, and the contact-beds of coke and cinders into which the sewage is run to undergo further the action of the aerobic bacteria, after which the nitrified sewage is in condition to be utilized for the fertilization of land, etc. The septic tanks are but a modification of the common cesspool, and are constructed of masonry, brick, and concrete.

There are a number of special applications of bacterial methods to sewage treatment into which we cannot go here.

The Immediate Disposal of Sewage. The final disposition of sewage is only one part of the problem of sewage disposal; the other part is the question how to remove it from the house into the street, and from the street into the places where it is finally disposed of.

The immediate disposal of sewage is accomplished by two methods—the so-called *dry* and *water-carriage* methods. By the *dry method* we mean the removal of sewage without the aid of water, simply collecting the dry and liquid portions of excreta, storing them for some time, and then removing them for final disposal. By the *water-carriage method* is understood the system by which sewage, solid and liquid, is flushed out by means of water, through pipes or conduits called sewers, from the houses through the streets to its final destination.

The Dry Methods. The dry or conservancy method of sewage disposal is a primitive method used by all ancient peoples; in China at the present time, and in all villages and sparsely populated districts. It has for its basic principle the return of all excreta to mother earth, to be used and worked over in that natural laboratory. The excreta are simply left in the ground to undergo in the soil the various organic changes, the difference in method touching only the vessels of collection and storage.

The methods are:

(1) the use of cesspools and privy-vaults.

(2) the pail system.

Disposal by means of the Privy-vault is the method usually employed in villages, in some towns, and even in some large cities, wherever sewers are not provided. In its primitive, and unfortunately its common, form, the privy-vault is nothing but a hole dug in the ground near or at some distance from the house; the hole is but a few feet deep, with a plank or rough seat over it, and an improvised shed over that. The privy is filled with the excreta; the liquids drain into the adjacent ground, which becomes saturated, and contaminates the nearest wells and watercourses. The solid portion is left to accumulate until the hole is filled or the stench becomes unbearable, then the hole is either covered up and forgotten, or the excreta are removed and the hole is used again. This is the usual privy system so often found near the cottages and mansions of our rural populace, and even in towns.

In the South the terrible ravages of the hook-worm

disease are mainly due to soil pollution and unsanitary privies.

The principal parts of a privy are: the shed, the seat, and the receptacle into which the excreta are dropped. The shed in a sanitary privy should be made of tightly fitted boards with windows properly screened and doors well closed in order to prevent insects and flies from gaining access. The seat should be so arranged as to be convenient for use and should be free from the contamination of excreta. The receptacle or the place into which the sewage is dropped should be more than a mere hole in the ground from which liquids percolate into the surrounding soil and in which the sewage remains and decomposes, it should be made water-tight by being lined with cement or some non-absorbent material. The sewage when dropped into this water-tight receptacle will remain there and must be removed from time to time. A still better method is to place in such water-tight receptacles a tight portable pail which is hung on a hook from the seat. The sewage is dropped directly into the pail which may be removed as soon as it fills up, the sewage being cremated or disinfected and the pail cleansed, washed and disinfected and returned to its place. For the purpose of removing these pails and cleaning the vault beneath the privy each part of the privy should be made with a sling cover so as to be accessible.

Cesspools. These may be used when the house is provided with fixtures and pipes to carry the sewage outside, and to collect it in a cesspool at a point distant from the house. The so-called "leeching" cesspools which are not water tight and allow liquids

to drain into ground are open to the same objections as privy-vaults. When cesspools are water tight they must be emptied at periodical intervals or provided with automatic ejectors and siphon apparata to discharge their contents. The best mode of discharge is by means of a system of intermittent filtration, or subsoil irrigation. The sewage is emptied into earthenware pipes with open joints, which lie several feet under ground and radiate in different directions, through land to be irrigated. The liquid sewage drains into the ground at the joints and is effectively disposed of, enriching the land.

Pail system. The pail system consists of the simple expedient of gathering the solid excreta into tight pails, or receptacles, and then removing the contents when full. Earth closets are somet mes used instead of pails.

The " earth closets " were introduced by the Reverend Moule, and at one time were extensively used in the United States.

The Water-carriage System. We now come to the modern method of using water to carry and flush all sewage material. This method is being adopted throughout the civilized world. For it is claimed the reduction of the mortality rate wherever it is introduced. The water-carriage system presupposes the construction and existence of pipes from the house to and through the street to the place of final disposition. The pipes running from the house to the streets are called house-sewers; and when in the streets, are called street-sewers.

The Separate and Combined Systems. Whenever the water-carriage system is used, it is either intended

to carry only sewage proper, viz., solid and liquid excreta flushed by water, or rain-water and other waste water from the household, in addition. The water-carriage system is accordingly divided into two systems: *the combined*, by which all sewage and all waste and rain-water are carried through the sewers, and the *separate* system, in which two groups of pipes are used: the sewers proper to carry sewage only, and the other pipes to dispose of rain-water and other uncontaminated waste water. Each system has its advocates, its advantages, and disadvantages. The advantages claimed for the separate system are as follows:

(1) the sewers may be of small diameter, not more than 6 inches;

(2) the constant, efficient flow and flushing of sewage is obtained;

(3) the sewage gained is richer in fertilizing matter;

(4) the sewers never overflow, as they often do in the combined system;

(5) the sewers being small, no decomposition takes place therein;

(6) sewers of small diameter need no special means of ventilation, or main traps on house-drains, and can be ventilated through the house-pipes.

On the other hand, the disadvantages of the separate system are:

(1) the need of two systems of sewers, for sewage and for rain-water, and the expense;

(2) the sewers used for sewage proper require some system for periodically flushing them, which, in the combined system, is done by occasional rains;

(3) small sewers cannot be as well cleaned or gotten at as larger ones;

The separate system has been used in Memphis and in Keene, N. H., for a number of years with complete satisfaction. Most cities, however, use the combined system.

CHAPTER VIII

SEWERS

Definitions. A sewer is a conduit or pipe intended for the passage of sewage, waste, and rain-water.

A *house-sewer* is the branch sewer extending from a point 2 feet outside of the outer wall of the building to its connection with the street-sewer, etc.

Materials. The materials from which sewers are constructed are iron, cement, and vitrified pipe.

Iron is used only for pipes of small diameter; and as most of the sewers are of greater diameter than 6 inches, they are made of other material than iron.

Cement and brick sewers are frequently used, and, when properly constructed, are effective, although the inner surface of the pipes is rough, which causes the adherence of sewage matter.

The most common material of which sewers are manufactured is earthenware or "vitrified pipe."

"Vitrified" pipes are manufactured of some kind of clay, and are salt-glazed inside. Good vitrified pipe must be circular and true in section, of a uniform thickness, perfectly straight, and free from cracks or other defects; it must be hard, tough, not porous, and have a highly smooth surface. The thicknesses of vitrified pipe are as follows:

4 inches diameter	.... $\frac{1}{2}$	inch thick
6 "	.... $\frac{11}{16}$	"
8 "	.... $\frac{3}{4}$	"
12 "	 1	"

The pipes are made in 2- and 3-foot lengths, with spigot- and socket-ends." (Gerhardt.)

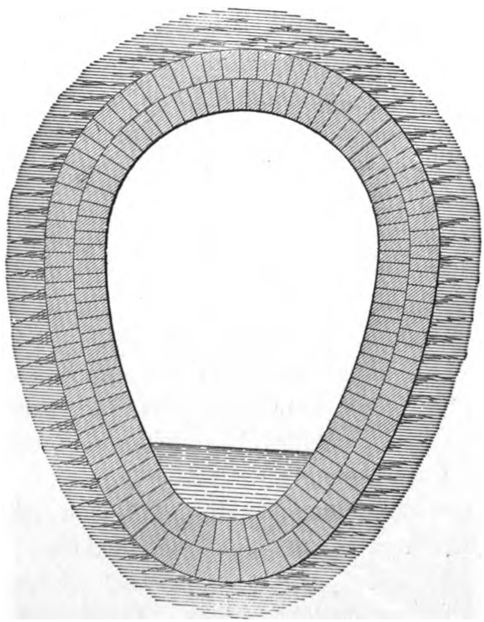

FIG. 7.—BRICK SEWER.

Sewer-pipes are laid in trenches at least 3 feet deep, to insure against the action of frosts.

Construction. The level of the trenches in which sewers are laid should be accurate, and a hard bed must be secured or prepared for the pipes to lie on. If the

ground is sandy and soft, a solid bed of concrete should be laid, and the places where the joints are should be hollowed out, and the latter embedded in cement.

Joints. The joints of the various lengths must be gas-tight, and are made as follows: Into the hub (the enlargement on one end of the pipe) the spigot-end of the next length is inserted, and in the space left between the two a small piece, or gasket, of oakum, is rammed in; the remaining space is filled in with a mixture of the best Portland cement and clean, sharp sand. The office of the oakum is to prevent the cement from getting on the inside of the pipe. The joint is then wiped around with additional cement.

Fall. In order that there may be a steady and certain flow of the contents of the sewer, the size and fall of the latter must be suitable; that is, the pipes must be laid with a steady, gradual inclination or fall toward the outlet. This fall must be even, without sudden changes, and not too great or too small.

The following has been determined to be about the right fall for the sizes stated:

4-inch pipe	....	1 foot in	40 feet	
6 "	....	1 "	60 "	
9 "	....	1 "	90 "	
12 "	....	1 "	120 "	

Flow. The velocity of the flow in sewers depends on the volume of their contents, the size of the pipes, and the fall. The velocity should not be less than 120 feet in a minute, or the sewer will not be self-cleansing.

Size. In order that the sewer may be self-cleansing, its size must be proportional to the work to be accom-

plished, so that it may be fully and thoroughly flushed and not permit the stagnation and consequent decomposition of its contents. If the sewer be too small, it will not be adequate for its purpose, and will overflow, back up, etc.; if too large, the velocity of the flow will be too low, and stagnation will result. In the separate system, where there is a separate provision for rain-water, the size of the sewer ought not to exceed 6 inches in diameter. In the combined system, however, when arrangements must be made for the disposal of large volumes of storm-water, the size of the sewer must be larger, thus making it less self-cleansing.

Connections. The connections of the branch sewers and the house-sewers with the main sewer must be carefully made, so that there shall be no impediment to the flow of the contents, either of the branches or of the main pipe. The connections must be made gas-tight; not at right angles or by T branches, but by bends, curves, and Y branches, in the direction of the current of the main pipe, and not opposite other branch pipes; and the junction of the branch pipes and the main pipe must not be made at the crown or at the bottom of the sewer, but just within the water-line.

Tide-valves. Where sewers discharge their contents into the sea, the tide may exert pressure upon the contents of the sewer and cause "backing up," blocking up the sewer, bursting open trap-covers, and overflowing into streets and houses. To prevent this, there are constructed at the mouth of the street-sewers, at the outlets to the sea, proper valves or tide-flaps, so constructed as to permit the contents of the sewers to flow out, yet prevent sea-water from backing up by

immediately closing upon the slightest pressure from outside.

House-sewers. Where the ground is "made," or filled in, the house-sewer must be made of cast iron, with the joints properly calked with lead. Where the soil consists of a natural bed of loam, sand, or rock, the house-sewer may be of hard, salt-glazed, and cylindrical earthenware pipe, laid in a smooth bottom free from projections of rock, and with the soil well rammed to prevent any settling of the pipe. Each section must be wetted before applying the cement, and the space between each hub and the small end of the next section must be completely and uniformly filled with the best hydraulic cement. Care must be taken to prevent any cement being forced into the pipe to form an obstruction. No tempered-up cement should be used. A straight-edge must be used inside the pipe, and the different sections must be laid in perfect line on the bottom and sides.

Connections of the house-sewer [when of iron] with the house main pipe must be made with lead-calked joints; the connection of the iron house-pipe with the earthenware house-sewer must be made with cement, and should be gas-tight.

Sewer-air and Gas. "Sewer-gas" is not a gas at all. What is commonly understood by the term is the air of sewers, the ordinary atmospheric air, but charged and contaminated with the various products of organic decomposition taking place in sewers. Sewer-air is a mixture of gases, the principal gases being carbonic acid; marsh gas; compounds of hydrogen and carbon; carbonate and sulphides of ammonium; ammonia;

sulphuretted hydrogen; carbonic oxide; volatile fetid matter; and organic putrefactive matter; and may also contain some bacteria, saprophytic or pathogenic.

Any and all the above constituents may be contained in sewer-air in larger or smaller doses, in minute or toxic doses.

It is evident that an habitual breathing of air in which even minute doses of toxic substances and gases are floating will in time impair the health of human beings, and that large doses of those substances may be directly toxic and dangerous to health. It is certainly an error to ascribe to sewer-air death-dealing properties, but it would be a more serious mistake to undervalue the evil influence of bad sewer-air upon health.

Ventilation. To guard against the bad effects of sewer-air, it is necessary to dilute, change, and ventilate the air in sewers. This is accomplished by means of the various openings left in the sewers, the so-called lamp and man-holes which ventilate by diluting the sewer-air with the street-air. In some places, chemical methods of disinfecting the contents of sewers have been undertaken with a view to killing the disease-germs and deodorizing the sewage. In the separate system of sewage disposal, where sewer-pipes are small and usually self-cleansing, the late Col. Waring proposed to ventilate the sewers through the house-pipes, omitting the usual disconnection of the house-sewer from the house-pipes.

Col. Waring was far in advance of his time, as recent investigations by a special committee of the British Parliament on the value of "intercepting traps" seem to have conclusively proven that there is no danger in

the omission of the main house trap; provided the plumbing system is gas-tight.

Rain-storms are the usual means by which a thorough flushing of the street-sewers is effected. There are, however, many devices proposed for flushing sewers; e.g., by special flushing-tanks, which either automatically or otherwise discharge a large volume of water, thereby flushing the contents of the street-sewers.

CHAPTER IX

PLUMBING—GENERAL PRINCIPLES

Purpose and Requisites of House-plumbing. A system of house-plumbing presupposes the existence of a street-sewer, and a water-supply distribution within the house. While the former is not absolutely essential, as a house may have a system of plumbing without there being a sewer in the street, still in the water-carriage system of sewage disposal the street-sewer is the outlet for the various waste and excrementitious matter of the house. The house-water distribution serves for the purpose of flushing and cleaning the various pipes in the house-plumbing.

The purposes of house-plumbing are: (1) to get rid of all excreta and waste water; (2) to prevent any foreign matter and gases in the sewer from entering the house through the pipes; and (3) to dilute the air in the pipes so as to make all deleterious gases therein innocuous.

To accomplish these results, house-plumbing demands the following requisites:

(1) *Receptacles* for collecting the waste and excreta. These receptacles, or plumbing fixtures, must be adequate for the purpose, small, non-corrosive, self-cleansing, well flushed, accessible, and so constructed as to dispose easily of their contents.

(2) *Separate vertical pipes* for sewage proper, for waste water, and for rain-water; they should be upright, direct, straight, non-corrosive, water- and gas-tight, well flushed, and ventilated.

(3) Short, direct, clean, well flushed, gas-tight branch pipes to connect receptacles with vertical pipes.

(4) *Disconnection* of the house-sewer from the house-pipes by the main trap on the house-drain, and disconnection of the house from the house-pipes by traps on all fixtures.

(5) *Ventilation* of the whole system by the fresh-air inlet, by vent-pipes, and the extension of all vertical pipes.

Definitions. The *house-drain* is the horizontal main pipe receiving all waste water and sewage from the vertical pipes, and conducting them outside of the foundation-walls, where it joins the house-sewer.

The *soil-pipe* is the vertical pipe or pipes receiving sewage matter from the water-closets in the house.

The *main waste-pipe* is the pipe receiving waste water from any fixtures except the water-closets.

Branch soil- and waste-pipes are the short pipes between the fixtures in the house and the main soil- and waste-pipes.

Traps are bends in pipes, so constructed as to hold a certain volume of water, called the water-seal; this water-seal serves as a barrier to prevent air and gases from the sewer from entering the house.

Vent-pipes are the special pipes to which the traps or fixtures are connected by short-branch vent-pipes, and serve to ventilate the air in the pipes, and prevent siphonage.

The *rain-leader* is the pipe receiving rain and storm-water from the roof of the house.

Materials Used for Plumbing Pipes. The materials of which the different pipes used in house-plumbing are made differ according to the use of each pipe, its position, size, etc. The following materials are used: cement, vitrified pipe, lead, cast, wrought, and galvanized iron, brass, steel, nickel, sheet metal, etc.

Cement and vitrified pipes are used for the manufacture of street- and house-sewers. In some places vitrified pipe is used for house-drains, but in most cities this is strongly objected to; and in New York City no earthenware pipes are permitted within the house. The objection to earthenware pipes are that they are not strong enough, break easily, and cannot be made gas-tight.

Lead pipe is used for branch waste-pipes, and for short lengths of water-pipe. The advantage of lead pipes is that they can be easily bent and shaped, hence their use for traps and connections. The disadvantage of lead for pipes is the softness of the material, which is easily broken into by nails, gnawed through by rats, etc.

Brass, nickel, steel, and other such materials are used in the manufacture of expensive plumbing, but are not commonly employed.

Sheet metal and *galvanized iron* are used for rain-leaders, refrigerator-pipes, etc.

Wrought iron is used in the so-called Durham system of plumbing. Wrought iron is very strong; the sections of pipe are 20 feet long, the connections are made by screw-joints, and a system of house-plumbing made

of this material is very durable, unyielding, strong, and perfectly gas-tight. The objections to wrought iron for plumbing-pipes are that the pipes cannot be readily repaired and that it is too expensive.

Cast iron is the material generally used for all vertical and horizontal pipes in the house. There are two kinds of cast-iron pipes manufactured for plumbing uses: the "standard" and the "extra heavy."

The following are the relative weights of each:

Standard.					Extra Heavy.
2-inch	pipe,	4	lbs.	per foot	$5\frac{1}{2}$ lbs.
3	"	6	"	"	$9\frac{1}{2}$ "
4	"	9	"	"	13 "
5	"	12	"	"	17 "
6	"	15	"	"	20 "
7	"	20	"	"	27 "
8	"	25	"	"	$33\frac{1}{2}$ "

The light-weight pipe, though extensively used by plumbers, is generally prohibited by most municipalities, as it is not strong enough, and as it is difficult to make a gas-tight joint with these pipes without breaking the hubs.

Cast-iron pipes are made in lengths of 5 feet each, with an enlargement on one end of the pipe, called the "hub" or "socket," into which the other, or "spigot" end, is fitted. All cast-iron pipe must be straight, sound, cylindrical and smooth, free from sand-holes, cracks, and other defects, and of a uniform thickness.

The thickness of cast-iron pipe should be as follows:

2-inch	pipe	$\frac{5}{16}$	inch thick.
3	"	$\frac{5}{16}$	"
4	"	$\frac{3}{8}$	"
5	"	$\frac{7}{16}$	"
6	"	$\frac{1}{2}$	"

Cast-iron pipes are sometimes coated by dipping them into hot tar, or by some other process. Tar-coating is, however, not allowed in New York, because it conceals the sand-holes and other flaws in the pipes.

Joints and Connections. To facilitate connections of cast-iron pipes, short and convenient forms and fittings are cast, as seen in Figs. 14 and 15. Some of these connections are named according to their shape, such as L, T, Y, etc.

Iron pipe is joined to *iron pipe* by lead-calked joints. These joints are made as follows: the spigot end of one pipe is inserted into the enlarged end, or the "hub," of the next pipe. The space between the spigot and hub is partly filled with oakum or dry hemp. The remaining space is filled with hot molten lead, which, on cooling, is well rammed and calked in by special tools made for the purpose. To make a good, gas-tight, lead-calked joint, experience and skill are necessary. The ring of lead joining the two lengths of pipe must be from 1 to 2 inches deep, and from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch thick; 12 ounces of lead must be used at each joint for each inch in the diameter of the pipe. Iron pipes are sometimes connected by means of so-called rust-joints. Instead of lead, the space between the socket and spigot is filled

in with an iron cement consisting of 98 parts of cast-iron borings, 1 part of flowers of sulphur, and 1 part of sal ammoniac.

All connections between *lead pipes* and between *lead* and *brass* or *copper* pipes must be made by means of "wiped" solder-joints. A wiped joint is made by solder being poured on two ends of the two pipes, the solder being worked about the joint, shaped into an oval lump, and wiped around with a cloth, giving the joint a bulbous form.

All connections between *lead pipes* and *iron pipes* are made by means of brass ferrules. The ferrule is joined to the lead pipe by a wiped joint, and to the iron pipe by an ordinary lead-calked joint.

Putty, *cement*, and *slip* joints should not be tolerated in any pipes.

Traps. We have seen that a trap is a bend in a pipe so constructed as to hold a quantity of water sufficient to interpose a barrier between the sewer and the fixture. There are many and various kinds of traps, some depending on water alone for their "seal," others employing mechanical means, such as balls, valves, lips, etc., to assist in the disconnection between the house and sewer ends of the pipe system.

The value of a trap depends: (1) on the depth of its water-seal; (2) on the strength and permanency of the seal; (3) on the diameter and uniformity of the trap; (4) on its simplicity; (5) on its accessibility; and (6) on its self-cleansing character.

The depth of a trap-seal should be about 3 inches for water-closet traps, and about 2 inches for sink and other traps.

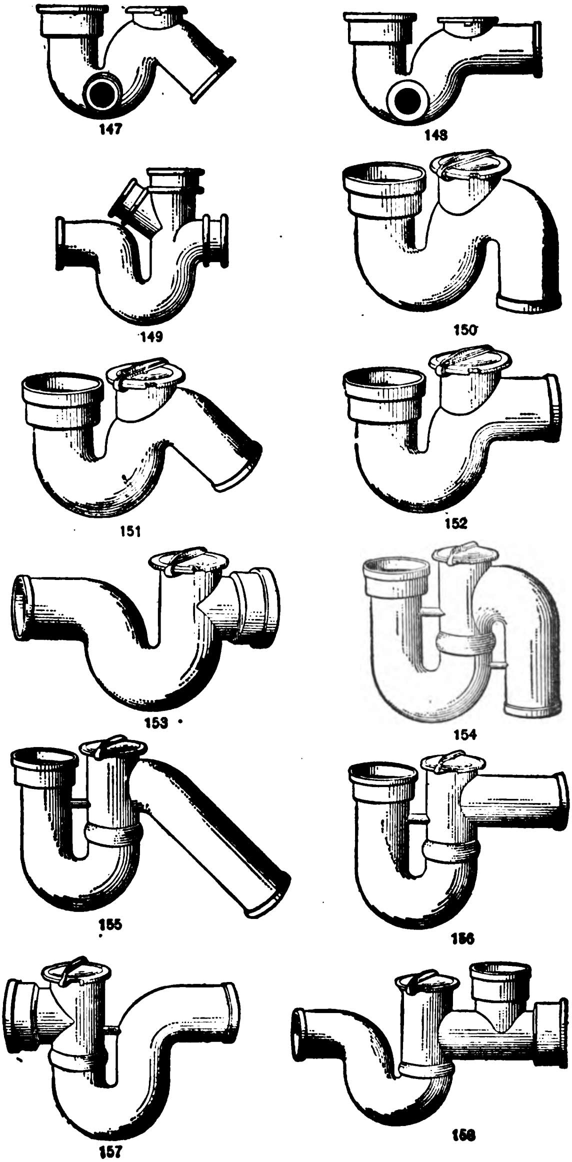

Fig. 8.

Traps must not be larger in diameter than the pipe to which they are attached.

The simpler the trap, the better it is.

Traps should be provided with cleanout screw-openings, caps, etc., to facilitate cleaning.

The shapes of traps vary, and the number of the various kinds of traps manufactured is very great.

Traps have been variously named, some according to their use, for instance, grease, sediment, intercepting traps; others according to their shape, D, P, S, V, bell, bottle, pot, globe, etc.; others according to the name of their inventor. The S, ½S, and ¾S are the most popular traps where the venting system is employed, while various non-siphoning traps are the ones which are used where vents are absent.

Loss of Seal by Traps. The seals of traps are not always secure, and the causes of the unsealing of traps are as follows:

(1) *Evaporation.* If a fixture in a house is not used for a long time, the water constituting the seal in the trap of the fixture will evaporate; the seal will thus be lost, and ingress of sewer-air will result. To guard against evaporation, fixtures must be frequently flushed; and during summer, or at times when the house is unoccupied and the fixtures not used, the traps should be filled with oil or glycerine, either of which will serve as an efficient seal.

(2) *Momentum.* A sudden flow of water from the fixture may, by the force of its momentum, empty all water in the trap and thus leave it unsealed. To prevent the unsealing of traps by momentum, they must be of a proper size, not less than the waste-pipe of the

fixture, the seal must be deep, and the trap in a perfectly straight position, as a slight inclination will favor its emptying. Care should also be taken while emptying the fixture to do it slowly so as to preserve the seal.

(3) *Capillary attraction.* If a piece of paper, cotton, thread, hair, etc., remains in the trap, and a part of the paper, etc., projects into the lumen of the pipe, a part of the water will be withdrawn by capillary attraction from the trap and may unseal it. To guard against the unsealing of traps by capillary attraction, traps should be made of uniform diameter, without nooks and corners and of not too large a size, and should also be well flushed, so that nothing but water remains in them.

Siphonage and Back-pressure. The water in the trap, or the "seal," is suspended between two columns of air, one from the fixture to the seal, the other from the seal of the trap to the seal of the main trap on the house-drain. The seal in the trap is therefore not very secure, as it is influenced by any and all currents and agitations of air from both sides, and especially from its distal side. Any heating of the air in the pipes with which the trap is connected, any increase of temperature in the air contents of the vertical pipes with which the trap is connected and any evolution of gases within those pipes will naturally increase the weight and pressure of the air within them, with the result that the increased pressure will influence the contents of the trap, or the "seal," and may dislodge the seal backward, if the pressure is very great, or, at any rate, may force the foul air from the pipes through the seal of the traps and foul the water in them, thus allowing foul odors to enter the

rooms from the traps of the fixtures. This condition, which in practice exists oftener than it is ordinarily thought, is called "back-pressure." By "back-pres-

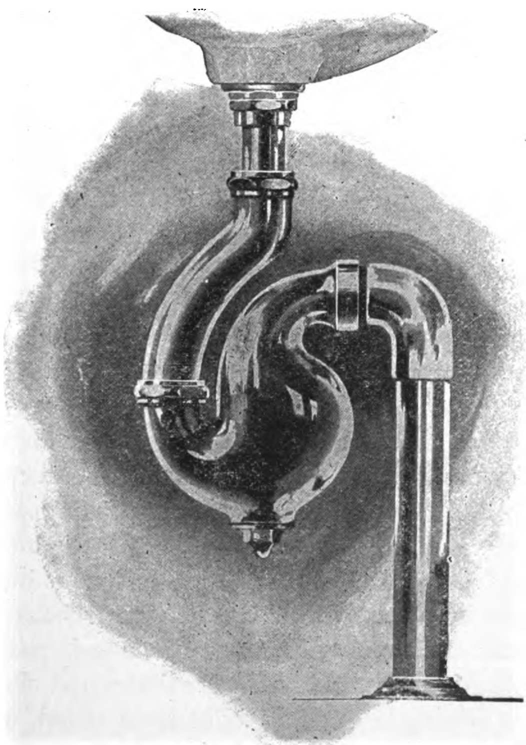

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FIG. 9.—NON-SIPHONING TRAP.

sure" is therefore understood the *forcing back*, or, at least, the *fouling*, of the water in traps, due to the increased pressure of the air within the pipes back of the traps; the increase in air-pressure being due to

the heating of pipes by the hot water occasionally circulating within them, or by the evolution of gases due to the decomposition of organic matter within the pipes.

A condition somewhat similar but acting in a reverse way is presented in what is commonly termed "siphonage." Just as the seal in traps may be forced back by the increased pressure of the air within the pipes, the same seal may be *forced out,* pulled out, aspirated, or siphoned out by a sudden withdrawal of a large quantity of air from the pipes with which the trap is connected. Such a sudden withdrawal of large quantities of air is occasioned every time there is a rush of a large column of water through the pipes, e.g., when a water-closet or similar fixture is suddenly discharged; the water rushes through the pipes with a great velocity and creates a strong down-current of air, with the result that where the down-rushing column passes by a trap, the air in the trap and later its seal are aspirated or siphoned out, thus leaving the trap without a seal. By "siphonage" is therefore meant the emptying of the seal in a trap by the aspiration of the water in the trap due to the downward rush of water and air in the pipes with which the trap is connected.

To guard against the loss of seal through siphonage "non-siphoning" traps have been invented, that is, the traps are so constructed that the seal therein is very large, and the shape of the traps made so that siphonage is difficult. Fig. 10 shows such a trap. These traps are, however, open to the objection that in the first place they do not prevent the fouling of the seals by back-pressure, and in the second place they are not easily cleaned and may retain dirt in their

large pockets. The universal method of preventing both siphonage and back-pressure is by the system of vent-pipes, or what plumbers call "back-air" pipes. Every trap is connected by branches leading from the crown or near the crown of the trap to a main vertical pipe which runs through the house just as the waste- and soil-pipes do, and which contains nothing but air, the air serving as a medium to be pressed upon by the "back-pressure" air, or to be drawn upon by the siphoning, thus preventing any agitation and influence upon the seal in the traps; for it is self-evident that as long as there is plenty of air at the distal part of the seal, the seal itself will remain uninfluenced by any agitation or condition of the air within the pipes with which the trap is connected.

The vent-pipe system is also an additional means of ventilating the plumbing system of the house already partly ventilated by the extension of the vertical pipes above the roof and by the fresh-air inlet. The principal objection urged against the installation of the vent-pipe system is the added expense, which is considerable; and plumbers have sought therefore, to substitute for the vent-pipes various mechanical traps, also non-siphoning traps. The vent-pipes are, however, worth the additional expense, as they are certainly the best means to prevent siphonage and back-pressure and are free from the objections against the cumbersome mechanical traps and the filthy non-siphoning traps.

There has been lately an agitation among designers of plumbing systems to do away with the cumbersome venting pipes which add so much to the cost of plumbing and also make the plumbing system in the

house unduly complicated. The advocates of the "one-pipe" system, with Dr. William Paul Gerhard in the lead, assert that it is time to abandon the old system of venting pipes and to introduce the one-pipe system, omitting the installation of vent-pipes, and instead making the traps so that they may not be siphoned easily. There seems to be no doubt that the present house-plumbing system needs to be greatly simplified and that the complicated and cumbersome net of pipes it necessitates is destined to be eliminated from the plumbing system with the passing of the bugaboo of the "filth theory" and the theory of "sewer-gas infection."

CHAPTER X

PLUMBING-PIPES

The House-drain. All waste and soil matter in the house is carried from the receptacles into the waste- and soil-pipes, and from these into the house-drain, the main pipe of the house, which carries all waste and soil into the street-sewer. The house-drain extends from the junction of the soil- and waste-pipes of the house through the house to within 2–5 feet outside of the foundations; whence it is called "house-sewer." The house-drain is a very important part of the house-plumbing system. Great care must be taken to make its construction perfect.

Material. The material of which house-drains are manufactured is extra heavy cast iron, and galvanized iron. Lighter pipes should never be used, and the use of vitrified pipes for this purpose should not be allowed.

Size. The size of the house-drain must be proportional to the work to be performed. Too large a pipe will not be self-cleansing, and the bottom of it will fill with sediment and slime. Were it not for the need of carrying off large volumes of storm-water, the house-drain could be a great deal smaller than it usually is. A 3-inch pipe is sufficient for a small house, though a

4-inch pipe is made obligatory in most cities. In New York City no house-drains of smaller diameter than 6 inches are allowed.

Fall. The fall or inclination of the house-drain depends on its size. Every house-drain must be laid so that it shall have a certain inclination toward the house-sewer, in order to increase the velocity of the flow in it and make it self-flushing and self-cleansing.

The rate of the pitch is usually from $\frac{1}{4}$ to $\frac{1}{2}$ inch to the foot, and should be adjusted according to the size of the pipe. For 6-inch pipes the fall should be not less than 1 foot to 60 feet, and, better, should be 1 foot to 30 feet, with a correspondingly greater pitch for other sizes of pipes.

Position. The house-drain lies in a horizontal position in the cellar, and should, if possible, be exposed to view. It should be hung on the cellar-wall or ceiling, unless this is impracticable, as when the fixtures in the cellar discharge into it; in this case it must be laid in a trench cut at a uniform grade, walled upon the sides with bricks laid in cement, and provided with movable covers and with a hydraulic-cement base 4 inches thick, on which the pipe is to rest. The house-drain must be laid in straight lines, if possible; all changes in direction should be made with curved pipes, the curves to be of a large radius.

Connections. The house-drain must connect properly with the house-sewer at a point about 2 feet outside of the outer front vault or area-wall of the building. An arched or other proper opening in the wall must be provided for the drain, to prevent damage by settlement.

All joints of the pipe must be gas-tight and lead-çalked, as stated before. The junction of the vertical soil-, waste-, and rain-leader pipes must not be made with right-angle joints, but by a curved-elbow fitting of a large radius, or with "Y" branches and 45-degree bends.

When the house-drain does not rest on the floor, but is hung on the wall or ceiling of the cellar, the con-

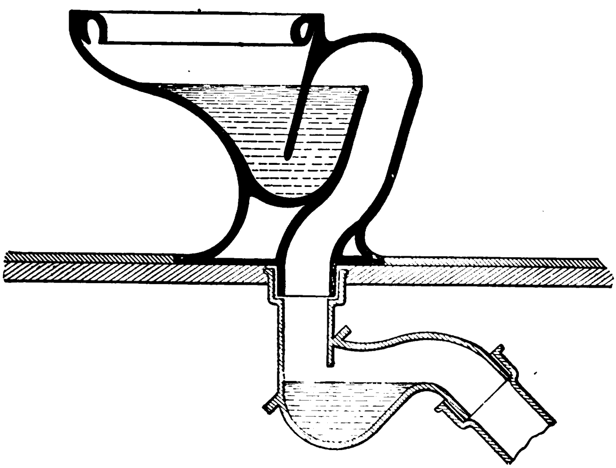


FIG 10.—SECTION OF A SIPHON WATER-CLOSET.
(Taken from "The Water Supply, Sewerage and Plumbing of Modern City Buildings.")
By Courtesy of Dr. William Paul Gerhard.

nection of the vertical soil- and waste-pipes must have suitable supports, the best support being a brick pier laid 9 inches in cement and securely fastened to the wall.

Near all bends, traps, and connections of other pipes with the house-drain, suitable handholes should be provided, these handholes to be tightly covered by brass screw-ferrules, screwed in and fitted with red lead.

"No steam-exhaust, boiler blow-off, or drip-pipe shall be connected with the house-drain or sewer. Such pipes must first discharge into a proper condensing-tank, and from this a proper outlet to the house-sewer outside of the building must be provided."

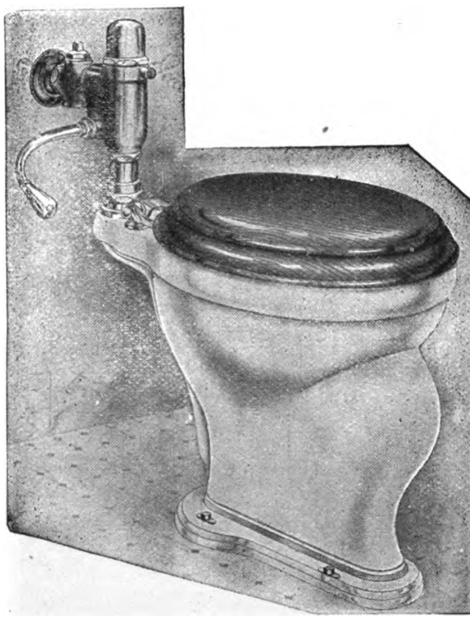


FIG. 11.—A MODERN WATER-CLOSET WITH FLUSHOMETER.

Main traps. The disconnection of the house-pipes from the street-sewer is accomplished by means of a trap on the house-drain near the front wall, inside the house, or just outside the foundation-wall, usually inside of the house. The best trap for this purpose is the siphon or running-trap. This trap must be constructed with a

cleaning handhole on the inside or house side of the trap, or on both sides, and the handholes should be covered and made gas-tight with brass screw-ferrules.

Extension of vertical pipes. The house-plumbing system is disconnected from the sewer by means of the main trap; and by means of the traps in each fixture, from the air in the rooms; still, as the soil-, waste-, and drain-pipes usually contain offensive solids and liquids which contaminate the air in the pipes, a good method provides for the ventilation of these pipes. The ventilation of the soil-, waste-, and house-drain pipes prevents the bad effects on health of the odors, etc., given off by the slime and excreta adhering to the pipes, and is accomplished by two means: (1) by the extension of the vertical pipes to the fresh air above the roof, and (2) by means of a fresh-air inlet in the house-drain.

By these means a current of air is established through the vertical and horizontal pipes.

Every vertical pipe must be extended at least 2 feet above the highest coping of the roof or chimney. The extension must be far from the air-shafts, windows, ventilators, and mouths of chimneys, so as to prevent air from the pipes being drawn into them. The extension must be not less than the full size of each pipe, so as to avoid friction from the circulation of air. The use of covers, cowls, return-bends, etc., is reprehensible, as they interfere with the free circulation of air. A wire basket may be inserted to prevent foreign substances from falling into the pipes.

Fresh-air inlet. The fresh-air inlet is a pipe of about 4 inches in diameter; it enters the house-drain on the house side of the main trap, and extends to the outside

air at or near the curb, or at any convenient place, at least 15 feet from the nearest window. The fresh-air inlet pipe usually terminates in a receptacle covered by an iron grating, and should be far from the cold-air box of any hot-air furnace. When clean, properly cared for, and extended above the ground, the fresh-air inlet, in conjunction with the open extended vertical pipe, is an efficient means of ventilating the air in the house-pipes; unfortunately, most fresh-air inlets are constantly obstructed, and do not serve the purpose for which they are made.

The Soil- and Waste-pipes. The soil-pipe receives liquid and solid sewage from the water-closets and urinals; the waste-pipe receives all waste water from sinks, wash-basins, bath-tubs, etc.

The material of which the vertical soil- and waste-pipes are made is cast iron.

The size of main waste-pipes is from 3 to 4 inches; of main soil-pipes, from 4 to 5 inches; in tenement houses with five water-closets or more, not less than 5 inches.

The joints of the waste- and soil-pipes should be lead-calked. The connections of the lead branch pipes or traps with the vertical lines must be by means of Y-joints, and by means of brass ferrules, as explained above.

The location of the vertical pipes must never be within the wall, built in, or outside the house, but should be preferably in a special 3-foot square shaft adjacent to the fixtures, extending from the cellar to the roof, where the air-shaft should be covered by means of a louvred skylight; that is, with a skylight with slats outwardly inclined, so as to favor ventilation.

The vertical pipes must be accessible, exposed to view in all their lengths, and, when covered with boards, so fitted that the boards may be readily removed.

Vertical pipes must be extended above the roof in full diameter, as previously stated. When less than 4 inches in diameter, they must be enlarged to 4 inches at a point not less than 1 foot below the roof-surface by an "increaser" of not less than 9 inches in length.

All soil- and waste-pipes must, whenever necessary, be securely fastened with wrought-iron hooks or straps.

Vertical soil- and waste-pipes must not be trapped at their base, as the trap would not serve any purpose, but the prevention of a perfect flow of the contents.

Branch Soil- and Waste-pipes. The fixtures must be near the vertical soil- and waste-pipes in order that the branch waste- and soil-pipes shall be as short as possible. The trap of the branch soil- and waste-pipes must not be far from the fixture, not more than 2 feet from it, otherwise, the accumulated foul air and slime in the waste- and soil-branch will emit bad odors.

The minimum sizes for branch pipes should be as follows:

Kitchen sinks	2 inches.
Bath-tubs	$1\frac{1}{2}$ to 2 inches.
Laundry-tubs	$1\frac{1}{2}$ to 2 inches.
Water-closets	not less than 4 inches.

Branch soil- and waste-pipes must have a fall of at least $\frac{1}{4}$ inch to 1 foot.

The branch waste- and soil-pipes and traps must be exposed, accessible, and provided with screw-caps, etc., for inspection and cleaning purposes.

Each fixture should be separately trapped as close to the fixture as possible, as two traps on the same line of branch waste- or soil-pipes will cause the air between the traps to be closed in, forming a so-called "cushion" that will prevent the ready flow of contents.

"All traps must be well supported and rest true with respect to their water-level."

Vent-pipes and their Branches. The purpose of vent-pipes, we have seen, is to prevent the siphoning of traps and to ventilate the air in the traps and pipes. The material of which vent-pipes are made is cast iron.

The size of vent-pipes depends on the number of traps with which they are connected; it is usually 2 or 3 inches. The connection of the branch vent to the trap must be at the crown of the trap, and the connection of the branch vent to the main vent-pipe must be above the trap, so as to prevent friction of air. The vent-pipes are not perfectly vertical, but are laid with a continuous slope so as to prevent the condensation of air or vapor in them.

The vent-pipes should be extended above the roof, several feet above coping, etc.; the extension above the roof should not be less than 4 inches in diameter, so as to avoid obstruction by frost. No return-bends or cowls should be tolerated on top of the vent-pipes. Sometimes the vent, instead of running above the roof, is connected with the soil-pipe several feet above all fixtures.

Rain-leaders. The rain-leader serves to collect the rain-water from the roof and eaves-gutter. It usually discharges its contents into the house-drain, although some leaders go to the street-gutter, while others

are connected with school-sinks in the yard. The latter practice is objectionable, as it may lead the foul air from the school-sink into the rooms, the windows of which are near the rain-leader; besides, the stirring up of the contents of the school-sink produces bad odors. When the rain-leader is placed within the house, it must be made of cast iron with lead-calked joints; when

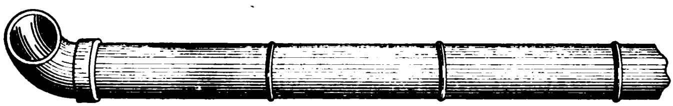


FIG. 12.—LEADER-PIPE.

outside, as is the rule, it may be of sheet metal or galvanized-iron pipe with soldered joints. When the rain-leader is run near windows, the rules and practice are that it shall be trapped at its base, the trap to be a deep one to prevent evaporation, and that it shall be placed several feet below the ground, so as to prevent freezing.

CHAPTER XI

PLUMBING FIXTURES

The receptacles or fixtures within the house for receiving the waste and excrementitious matter and carrying it off through the pipes to the sewer are very important parts of house-plumbing. Great care must be bestowed upon the construction, material, fitting, etc., of the plumbing fixtures, in order that they may be a source of comfort in the house instead of a curse to the occupants.

Sinks. The waste water from the kitchen is disposed of by means of sinks. Sinks are usually made of cast iron, painted, enamelled, or galvanized. They are also made of wrought iron, as well as of earthenware and porcelain. Sinks must be set level, and provided with strainers at the outlet to prevent large particles of kitchen-refuse from being swept into the pipes and obstructing them. If possible, the back and sides of a sink should be cast from one piece; the back and sides, when of wood, should be covered by non-absorbent material, to prevent the wood from becoming saturated with waste water. No woodwork should enclose sinks; they should be supported on iron legs and be open beneath and around. The trap of a sink is usually 2 inches in diameter, and should be near the sink; it should have

a screw-cap for cleaning and inspection; the branch vent-pipe should be at the crown of the trap.

Wash-basins. Wash-basins are placed in bath-rooms, and, when properly constructed and fitted, are a source of comfort. They should not be located in bed-rooms, and should be open, without any woodwork around them. The wash-bowls are made of porcelain or marble, with a socket at the outlet, into which a plug is fitted.

Wash-tubs. For laundry purposes wooden, stone, porcelain, and enamelled iron tubs are fitted in the kitchen or laundry-room. Porcelain is the best material, although very expensive. The soapstone tub is the next best; it is clean, non-absorbent, and not too expensive. Wood should never be used, as it soon becomes saturated, is foul, leaks, and is offensive. In old houses, wherever there are wooden tubs, they should be covered with zinc or some non-absorbent material. The wash-tubs are placed in pairs, sometimes three in a row, and are generally connected with a single lead waste-pipe $1\frac{1}{2}$ to 2 inches in diameter having one trap for all the tubs.

Bath-tubs. Bath-tubs are made of enamelled iron or porcelain, and should not be covered or enclosed with any woodwork. The branch waste-pipe should be trapped and connected with the main waste- or soil-pipe. The floor about the tub in the bathroom should be of non-absorbent material.

Refrigerators. The waste-pipes of refrigerators should not connect with any of the house-pipes, but should be emptied into basins or pails; or, if the refrigerator is large, its waste-pipe should be conducted to the

cellar, where it should discharge into a properly-trapped, sewer-connected, water-supplied, open sink.

Boilers. The sediment or emptying pipes of the hot-water boilers should be connected with the sink-trap at the inlet side of the trap, or provided with a draw cock and emptied by hand.

Urinals. As a rule, no urinals should be tolerated in a house; they are permissible only in factories and office buildings. The material of which they are made is enamelled iron or porcelain. They must be provided with a proper water-supply to flush them.

Overflows. To guard against the overflow of wash-basins, bath-tubs, etc., overflow-pipes from the upper portion of the fixtures are commonly provided. These pipes are connected with the inlet side of the trap of the same fixture. They are, however, liable to become a nuisance by being obstructed with dirt and by not being constantly flushed; whenever possible they should be dispensed with.

Safes and Wastes. A common practice with plumbers in the past was to provide sinks, wash-basins, bath-tubs, and water-closets, not only with overflow-pipes, but also with so-called safes, which consist of sheets of lead turned up several inches at the edges so as to catch all the drippings and overflow from fixtures; from these safes a drip- or waste-pipe is conducted to the cellar, where it empties into a sink. Of course, when such safe-wastes are connected with the soil- or waste-pipes, they become a source of danger, even if they are trapped, as they are not properly cared for nor flushed; and their traps are usually not sealed. Even when discharging into a sink in the cellar, safes and

safe-wastes are very unsightly, dirty, liable to accumulate filth, and are offensive. With open plumbing, and with the floors under the fixtures of non-absorbent material, there is no need for them.

Water-closets. The most important plumbing fixtures within the house are the water-closets. Upon the proper construction and location of the water-closets the health of the inhabitants of the house greatly depends. Water-closets should be placed in separate, well lighted, perfectly ventilated, damp-proof, and clean compartments; no water-closet should be used by more than one family in a tenement house. The type and construction of the water-closets should be carefully attended to, as the many existing, old and obsolete types of water-closets are still being installed in houses, or are left there to foul the air of rooms and apartments. There are many water-closets on the market, some of which will be described below; the best are those made of one piece, of porcelain or enamelled earthenware, and so constructed as always to be and to remain clean.

The pan closet. The water-closet most commonly used in former times was representative of the group of water-closets with mechanical contrivances. The *pan closet*, as it was called, is now universally condemned and prohibited from further use. The pan closet consists of 4 principal parts: (1) a basin of china, small and round; (2) a copper 6-inch pan under the basin; (3) a large iron container, in which the basin with the pan under it is placed; and (4) a D trap to which the container is joined. The pan is attached with a lever to a handle, which, when pulled, moves the pan, which describes a

half circle and drops its contents into the container and the trap. The objections to pan closets are the following:

(1) the large number of parts, and the mechanical contrivances in them which are liable to get out of order;

(2) the fact that the bowl is set into the container and cannot be inspected, and is usually very dirty beneath;

(3) the fact that the pan is often missing, gets out of order, and is liable to be soiled by adhering excreta;

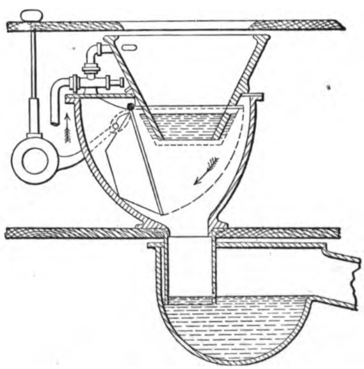


FIG. 13.—PAN WATER-CLOSET. (GERHARD.)

(4) that the container is large, that excreta adhere to its upper parts, that the iron becomes corroded and coated with filth;

(5) the fact that with every pull of the handle and the pan, foul air enters rooms;

(6) that the junctions between the bowl and the container, and the container and the trap, are usually not gas-tight;

(7) that the pan breaks the force of the water flush, and that the trap is usually not completely emptied.

Valve and plunger closets were an improvement upon

the pan closets, but are not free from several of the objections enumerated above. As a rule, all water-closets with mechanical parts are objectionable.

Hopper closets are made of iron or earthenware. Iron hopper closets easily corrode; they are usually enamelled on the inside. Earthenware hoppers are preferable to iron ones. Hopper closets are either long or short; when long, they expose a very large surface to fouling,

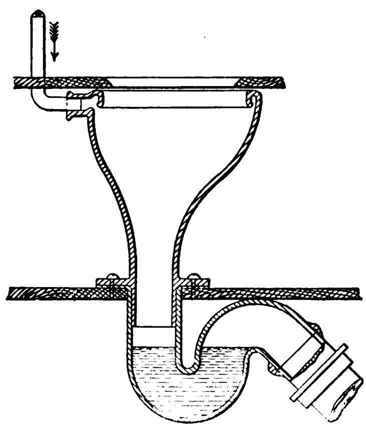


FIG. 14.—LONG HOPPER WATER-CLOSET. (GERHARD.)

they require a trap below the floor and are, as a rule, very difficult to clean or to keep clean. Short hopper closets are preferable, as they are easily kept clean and are well flushed. When provided with flushing-rim, and with a good water-supply cistern and large supply-pipe, the short hopper closet is a good form of water-closet.

The washout and washdown water-closets are an improvement upon the hopper closets. They are manu-

factured from earthenware or porcelain, and are so shaped that they contain a water-seal, obviating the necessity of a separate trap under the closet.

The wash-out water-closet is, however, very objectionable in that the force of the flush is broken by the large offset surface and by the fact that there is usually very little water in the offset and that excreta frequently adhere

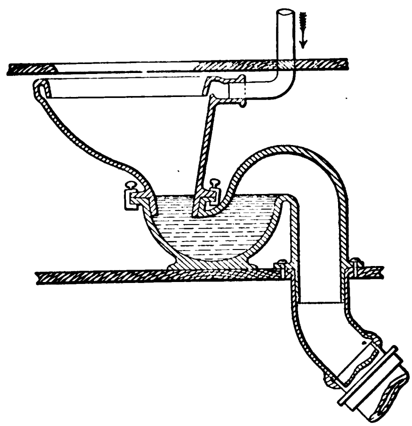


FIG. 15.—SHORT HOPPER WATER-CLOSET. (GERHARD.)

to it, and that it is difficult to flush out. The wash-out water-closet is therefore becoming obsolete (Fig. 18).

The best form of modern water-closet is the so-called siphon-closet, of which there is a large variety, although they are all constructed according to one principle. These closets are at present rapidly forcing out the older and less efficient kinds. See page 87.

Flush-tanks. Water-closets must not be flushed directly from the water-supply pipes, as there is a possibility of contaminating the water-supply. Water-

closets should be flushed from flush-tanks, either of iron or of wood, metal lined; these cisterns should be placed not less than 4 feet above the water-closet, and should be provided with a straight flush-pipe of at least $1\frac{1}{4}$ inch diameter.

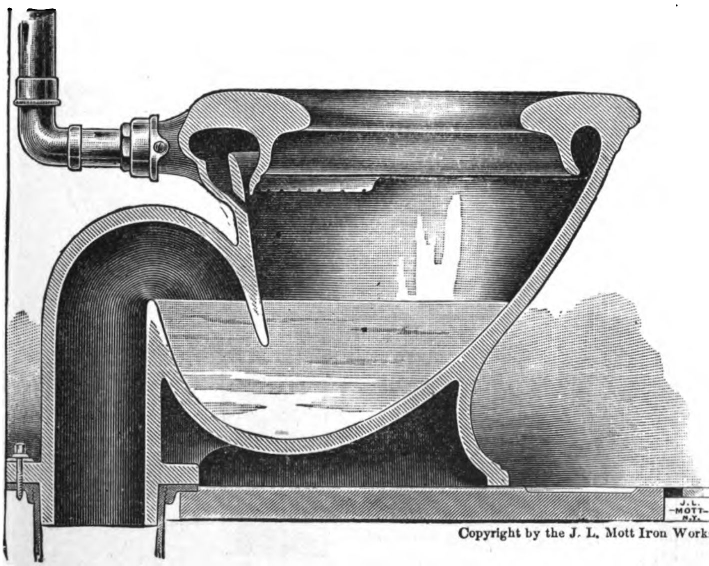


FIG. 16.—WASHDOWN WATER-CLOSET.

The cistern is fitted with plug and handle, so that by pulling at the handle the plug is lifted out of the socket of the cistern and the contents permitted to rush through the pipe and flush the water-closet. A separate ball arrangement is made for closing the water-supply when the cistern is full. The cistern should have a capacity of at least 3–5 gallons of water; the flush-pipe must have a diameter of not less than $1\frac{1}{4}$ inch; the

pipe should be straight, without bends, and the arrangement within the closets such as to flush all parts of the bowl at the same time.

There have been recently invented a number of devices called flushometers which have been designed to supplant the flushing tanks. Some of these flush-

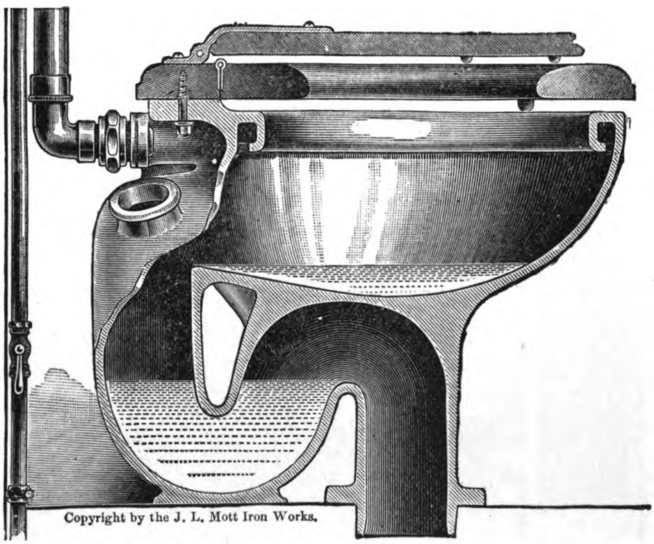


FIG. 17.—WASHOUT WATER-CLOSET.

ometers are good, but few are better than the old flushing tank. See page 88.

Yard Closets. The *school-sink* is an iron trough from 5 to 12 or more feet long, 1 to 2 feet wide and 1 foot deep, set in a trench several feet below the surface with an inclination toward the outlet; on one end of the trough there is a socket fitted with a plug, and on the other a flushing apparatus consisting simply

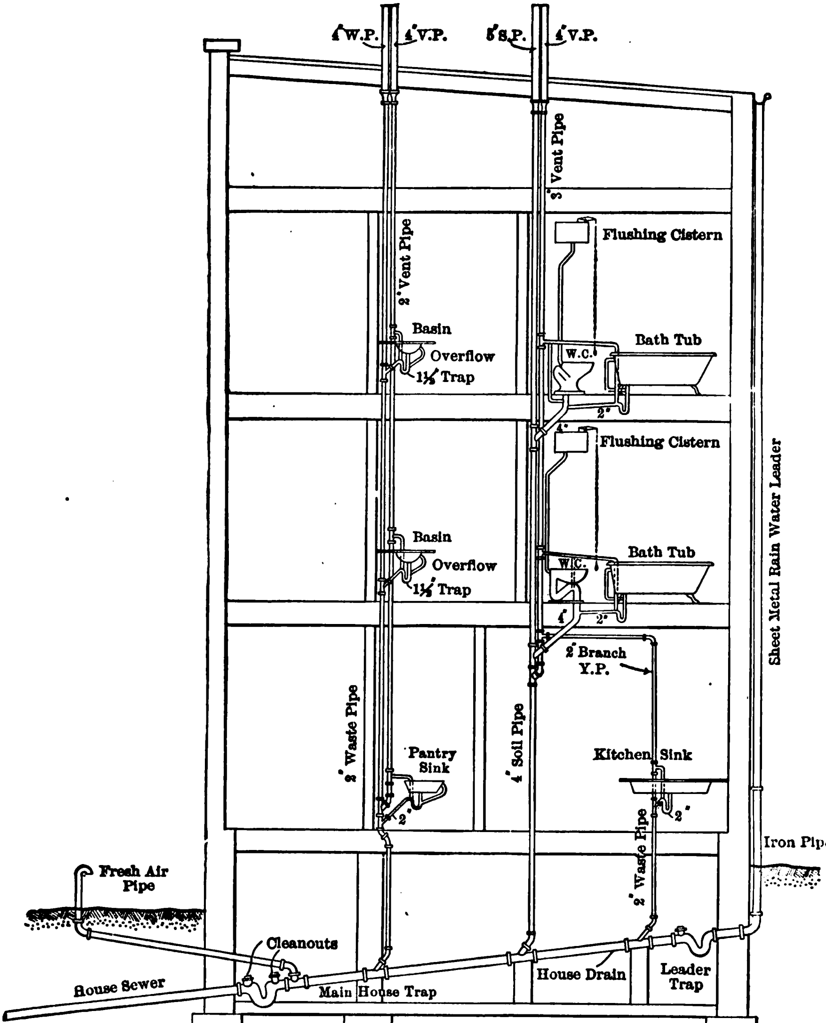


FIG. 18.—THE "TWO-PIPE" (VERTICAL) SYSTEM. (GERHARD.)

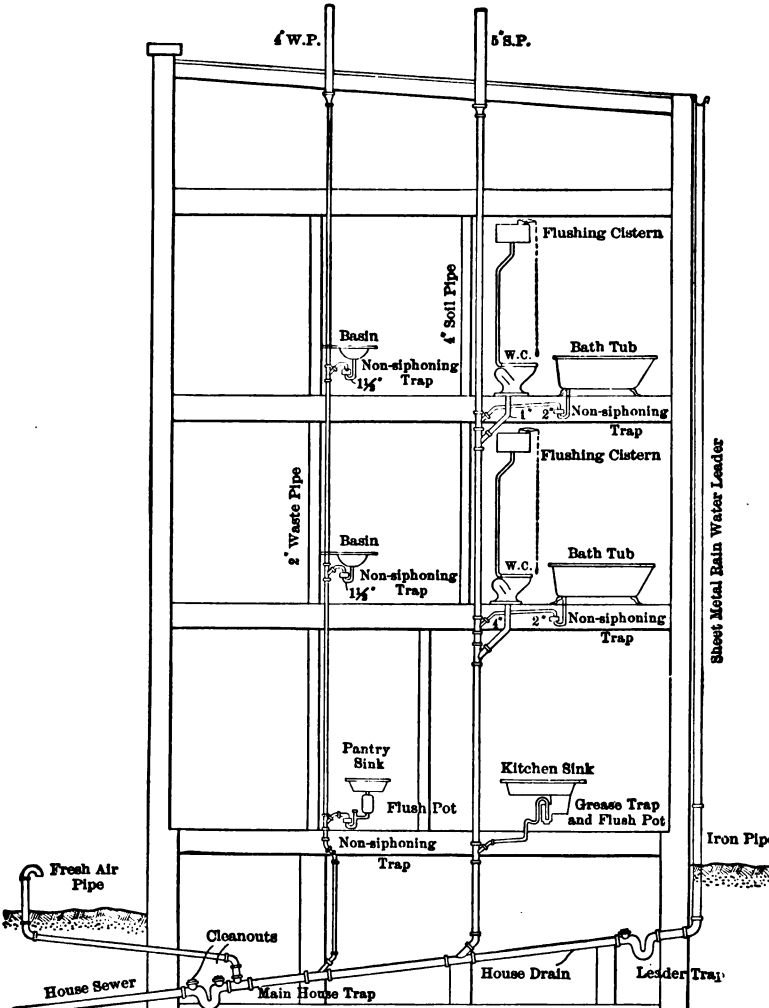


FIG. 19.—"ONE-PIPE" SYSTEM. (GERHARD.)

of a water service-pipe. Above the iron trough brick walls are built up, enclosing it; over it are placed wooden seats, and surrounding the whole is a wooden shed with compartments for every seat. The excreta are allowed to fall into the trough, which is partly filled with water, and once a day, or as often as the caretaker chooses, the plug is pulled up and the excreta allowed to flow into the sewer with which the school-sink is connected.

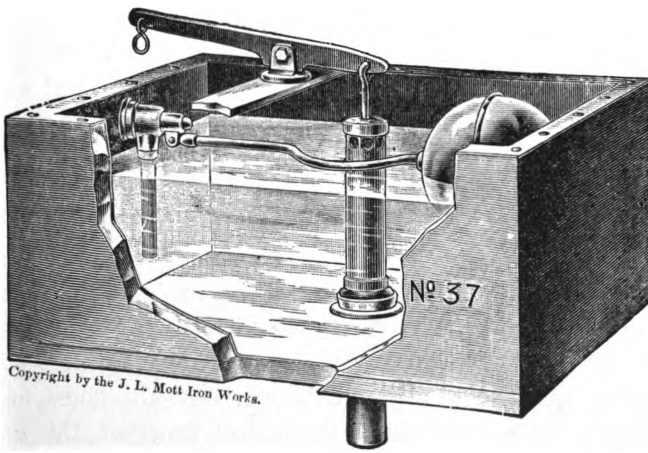


FIG. 20.—FLUSHING CISTERN.

These school-sinks are, as a rule, a nuisance, and are dangerous to health. The objections to them are the following:

(1) The excreta lies exposed in the iron trough, and may decompose even in one day; it is always offensive.

(2) The iron trough is easily corroded.

(3) The iron trough, being large, presents a large surface to the adherence of excreta.

(4) The brickwork above the trough is not flushed when the school-sink is emptied, and the excreta which usually adhere to it decompose, creating offensive odors.

(5) The junction of the iron trough with the brickwork, and the brickwork itself, are usually defective, or become defective, allowing foul water and sewage to pass into the yard, or into the wall adjacent to the school-sink. By the Tenement-house Law of New York, after 1901 the use of school-sinks is prohibited even in old buildings.

Yard hopper closets. Where the water-closet accommodations cannot, for some reason, be put within the house, yard hopper closets are commonly employed. These closets are simply long, iron enamelled hoppers, trapped, and connected with a drain-pipe discharging into the house-drain. These closets are flushed from cisterns, but, in such cases, the cisterns must be protected from freezing; this is accomplished in some houses by putting the yard hopper near the house and placing the cistern within the house; however, this can hardly be done where several hoppers must be employed. In most cases, yard hoppers are flushed by automatic rod-valves, so constructed as to flush the bowl of the hopper whenever the seat is pressed upon. These valves, as a rule, get out of order and leak frequently. Care must be taken to construct the vault under the hoppers so that it be perfectly water-tight.

This fixture, the school-sink and the pan closet as well, are becoming obsolete, and the time is not distant when they will not be found anywhere except in museums of antiquity.

Yard- and Area drains. The draining of the surface of the yard or other areas is done by tile or iron pipes connecting with the sewer or house-drain in the cellar. The " bell " or the " lip " traps are to be condemned and should not be used for yard drains. The gully and trap should be made of one piece; the trap should be of the siphon type and should be deep enough in the ground to prevent the freezing of seal in winter.

CHAPTER XII

DEFECTS IN PLUMBING; EXAMINATION AND TESTS

THE materials used in house plumbing are many and various, the parts are very numerous, the joints and connections are frequent, the position and location of pipes, etc., are often inaccessible and hidden, and the whole system quite complicated. Moreover, no part of the building is subjected to so many strains and uses, as well as abuses, as the plumbing of the house. Hence, in no part of house construction can there be as much bad work and "scamping" done as in the plumbing; no part of the house is liable to have so many defects in construction, maintenance, and condition as the plumbing. At the same time, the plumbing of a house is of very great importance and has an important influence on the health of the tenants, for defective materials, bad workmanship and improper condition of the plumbing of a house may endanger the lives of its inhabitants by causing various diseases.

Defects in Plumbing. The defects usually found in plumbing are so many that they cannot all be enumerated here. Among the principal and most common defects, however, are the following:

Defective Materials. Light-weight iron pipes; these crack easily and cannot stand the strain of calking. Pipes with sand-holes in them made during casting; these holes

cannot always be detected, especially when the pipes are tar-coated. Thin lead pipe, not heavy enough to withstand the bending and drawing it is subjected to.

Defective Location and Position. Pipes may be located within the walls or built in, in which case they are inaccessible, and may be defective without any one being able to discover the defects. Pipes may be laid with a wrong or an insufficient fall, thus leaving them unflushed or retarding the proper velocity of the flow in the pipes. Pipes may be put underground and have no support underneath, when some parts or lengths may sink, get out of joint and the sewage run into the ground instead of through the pipes. The pipes may be so located as to require sharp bends and curves, which will retard the flow in them.

Defective Joints. Joints in pipes may be defective, leaking and not gas-tight, because of imperfect calking, insufficient lead having been used, or because no oakum having been used, the lead has run into the lumen of the pipe; or because sufficient care and time have not been taken for the work. Joints may be defective because of iron ferrules being used instead of brass ferrules; through improperly wiped joints; through bad workmanship, bad material, or the ignorance of the plumber. Plumbers often use T branches instead of Y branches; sharp bends instead of bends of 45 degrees or more; slip joints instead of lead-calked ones; also, they often connect a pipe of larger diameter with a pipe of small diameter, etc.

Traps. The traps may be bad in principle and in construction; they may be badly situated or connected, or they may be easily unsealed, frequently obstructed inaccessible and foul.

Ventilation. The house-drain may have no fresh-air inlet, or the fresh-air inlet may be obstructed; the vent-pipes may be absent, or obstructed; the vertical pipes may not be extended.

Condition. Pipes may have holes, may be badly repaired, may be bent, out of shape, or have holes patched up with cement or putty; pipes may be corroded, gnawed by rats, or they may be obstructed, etc.

The above are only a few of the many defects that may be found in the plumbing of a house. It is, therefore, of paramount importance to have the house plumbing regularly, frequently, and thoroughly examined and inspected, as well as put to the various tests, so as to discover the defects and remedy them.

Plumbing Tests. The following are a few minor points in testing plumbing:

(1) To test a trap with a view to finding out whether its seal is lost or not, knock on the trap with a piece of metal; if the trap is empty, a hollow sound will be given; if full, the sound will be dull. This is not reliable in case the trap is full or half-full of slime, etc. Another test for the same purpose is to hold a light near the outlet of the fixture. If the light is drawn in, it is a sign that the tap is empty.

(2) Defects in leaded joints may be detected if white lead has been used, as that will be discolored if sewer-gas escapes from the joints.

(3) The connection of the waste-pipe of a bath-tub with the trap of the water-closet can sometimes be discovered by suddenly emptying the bath-tub and watching the contents of the water-closet trap; the

latter will be agitated if the waste-pipe is discharged into the trap or on the inlet side of trap of the water-closet.

(4) The presence of sewer-gas in a room can be detected by the following chemical method: Saturate a piece of unglazed paper with a solution of acetate of lead in rain or boiled water, in the proportion of 1 to 8; allow the paper to dry and hang it up in the room where the escape of sewer-gas is suspected; if sewer-gas is present, the paper will be blackened.

The main tests for plumbing are: (1) The *Hydraulic*, or water-pressure test; (2) the *Smoke*, or sight test; and (3) the *Scent*, or peppermint, etc., test.

The Water-pressure Test is used to test the vertical and horizontal pipes in new plumbing before the fixtures have been connected. The end of the house-drain is plugged up with a proper air-tight plug, of which there are a number on the market. The pipes are then filled with water to a certain level, which is carefully noted. The water is allowed to stand in the pipes for half an hour, at the expiration of which time, if the joints show no sign of leakage, and are not sweating, and if the level of the water in the pipes has not fallen, the pipes are water-tight. This is a very reliable test, and is made obligatory in testing all new plumbing work.

The Smoke Test is also a very good test. By means of bellows, or some exploding, smoke-producing rocket, smoke is forced into the system of pipes, the ends are plugged up, and the escape of the smoke watched for. Wherever there are defects in the pipes smoke will appear. A number of special appliances for this

test are manufactured, all of them more or less efficacious.

The Scent Test is made by putting into the pipes a certain quantity of some pungent chemical, like peppermint-oil, etc., the odor of which will escape through the defects in the pipe if there are any. Oil of peppermint is commonly used in this country for the test. All the openings of the pipes on the roof, except one, are closed up tightly with paper, rags, etc. Into the one open pipe from 2 to 4 ounces of peppermint-oil, followed by a pail of hot water are poured, then the pipe into which the oil has been put is plugged up also. This is done preferably by an asssitant. The inspector then proceeds to follow slowly the course of the various pipes, and will detect the smell of the oil wherever it may escape from any defects in the pipes. If the test is thoroughly and carefully done, if care is taken that no fixture in the house is used and that the traps of none of them are disturbed during the test, if the openings of the pipes on the roofs are plugged up tightly, if the main house-trap is not unsealed (otherwise the oil will escape into the sewer), and if the handling of the oil has been done by an assistant, so that none adheres to the inspector; if all these conditions are carried out, the peppermint test is a most valuable one for the detection of any and all defects in plumbing. Another precaution to be taken is with regard to the rain-leader. If the rain-leader is not trapped, or if its trap is empty, the peppermint-oil may escape from the pipes into the rain-leader. Care must be taken, therefore, that the trap at the base of the rain-leader is sealed; or, if there is no trap to close up the connection of the rain-leader with the

house-drain; or, if this is impossible, to plug up the opening of the leader near the roof.

Instead of putting the oil into the opening of a pipe on the roof, it may be put through a fixture on the top floor of the house, although this is not so satisfactory.

Various appliances have been manufactured to make this test easier and accurate. Of the English appliances, the Banner patent drain-grenade, and Kemp's drain-tester are worthy of mention. The former consists "of a thin glass vial charged with pungent and volatile chemicals. One of the grenades, when dropped down any suitable pipe, such as the soil-pipe, breaks, or the grenade may be inserted through a trap into the drain, where it is exploded." (Taylor.) Kemp's drain-tester consists of a glass tube containing a chemical with a strong odor; the tube is fitted with a glass cover, held in place by a spring and a paper band. When the tester is thrown into the pipes and hot water poured after it, the paper band breaks, the spring opens the cover, and the contents of the tube fall into the drain.

In making the test one must also see that the opening of the "fresh-air inlet" is closed to prevent the escape of the peppermint through the open "inlet."

PART SECOND

SANITARY PRACTICE

SECTION I—HABITATION

CHAPTER I

THE TENEMENT-HOUSE PROBLEM

"Man, in constructing protection from exposure, has constructed conditions of disease. In an age when he could not foresee the results of his own work, he created these conditions, and it is not fair to blame him, because he did not, in his primitive days, know better. We do know better now, and it is our fault if we do not improve on the original bad work, rectify it and remove intelligently the evils which, from deficient intelligence, have been so long perpetuated. This should be the uniform object of the sanitary scholar. The intention (and object) of domestic sanitation is so to construct homes for human beings, or, if the homes be constructed, so to improve them, that the various diseases and ailments incident to bad construction may be removed to the fullest possible extent."

BENJAMIN W. RICHARDSON, in *Health in the Home.*

THE above words of Dr. Richardson are the quintessence of the tenement-house problem and its solution.

In ignorance, in folly, and in carelessness, society had permitted certain conditions to exist and be per-

petuated, conditions vitally affecting life and health, which have been allowed to become a fearful menace to social prosperity.

In the relentless march of industrial progress and the fierce struggle for commercial superiority, modern cities have developed evils which threaten to undermine the very existence of urban life, and have created conditions which threaten to cause the extinction of cities by depopulating them through disease and plague due to defective sanitation.

Owing to various causes, a very large proportion (in New York State 71 per cent, according to the last census) of the population of the country is concentrated in cities; a large number of the city inhabitants are herded in small, confined areas; the majority of the urban population is compelled to crowd into the vast barrack-like structures called tenements, defective in construction, unsanitary in drainage, faulty in condition, lacking in light, air, and water—the three essentials of life.

These conditions cause the large average mortality of cities, the fearful slaughter of innocent infants and children, the dwarfing of the constitutions of the growing generation, the spreading of infection and contagion, the degeneration of the intellectual and the corruption of the moral life of the community.

The houses men live in bear an intimate relation to soil, light, air, water, and drainage. The influence of these upon health has already been spoken of. Moreover, the construction of houses, overcrowding, and the density of population, have each a direct influence on man's health and longevity.

Tuberculosis, the scourge of nations, is a disease of

over-crowded tenements; typhoid fever is a disease of defective drainage; the diarrhœas from which so many thousands of babies die every summer are tenement-house diseases. Rheumatism is a disease of damp and dark dwellings; smallpox, scarlet fever, and other human plagues spread like wildfire in crowded, ill-constructed, ill-ventilated, badly-lighted, and miserable tenement districts.

There are blocks in New York City with one thousand human beings to the square acre. There are blocks solidly built upon, with not more than 10 per cent of space left for air and light. There are barracks (mis-called houses) in which not less than 36 families make their home. There are floors in houses built on lots 25×100 feet with 6 families to a floor. There are apartments of 2 or 3 rooms each, containing 10 to 15 persons.

Where there is such density of population, that there cannot be sufficient light, air, or breathing space; hence the sanitary conditions are often horrible beyond description, and the moral pollution vile beyond mention.

Here are a few figures from statistics on the influence of dwellings upon health.

Dr. Farr gives the following figures on the relation of mortality to density of population (Notter and Firth):

86 people to the square mile.....	14 in 1000
172 " " "	17 " "
255 " " "	20 " "
1128 " " "	23 " "
3399 " " "	26 " "

Dr. Anderson, Medical Officer of Dundee, gives the following figures for the comparative death-rates of

inhabitants of one-, two-, three-, and four-room apartments (Dr. Sykes, Brit. Med. Jour.):

One-room	apartments.....	21.4 in 1000
Two-room	"	18.8 " "
Three-room	"	17.2 " "
Four-room	"	12.3 " "

According to the Report of the New York Tenement-house Commission for 1894, the death-rate in New York in the First Ward in single houses on one lot was 29.03; and in lots where there were front and rear houses the death-rate reached 61.97! In the same ward the death-rate of children under 5 years of age reached, in the former houses, 109.58, and in the latter the terrible rate of 204.55 in a thousand! It is hardly necessary to cite more figures to prove that overcrowding and the high death-rate walk hand in hand.

The tenement house is an offspring of municipal neglect, of overcrowding in small areas, of industrial expansion, of commercial encroachment, of poverty and destitution, of deficient transportation, and of the necessity of the working classes to dwell near their industrial occupations.

Originally, the tenement houses consisted of former private dwellings, whose occupants, being crowded out by commerce and manufacture, left them and moved into less crowded locations, leaving their houses to be occupied by the less fortunate, who were compelled to remain near their work. As population pressed on, these spacious houses were divided and subdivided without any control or regard to light and ventilation; hence, many apartments were soon overfilled, and

the demand for such homes induced the wide-awake real-estate men to build houses expressly for poor tenants. That these buildings were constructed with no regard for proper sanitation, etc., goes without saying; for in those times there were no restrictive laws, and every builder and speculator constructed houses with the sole idea of crowding the largest possible number of families into it, and of getting the largest amount of rent that could possibly be gotten out of them.

It was then that the cry of the philanthropists went up (*vide* first report of the "Committee on Housing" of the Association for the Improvement of the Poor, 1853): "Pure air, light, and water, being indispensable to health and life, if tenements are so badly constructed as to preclude a proper supply of these essential elements, the *law* should interpose for the protection of the sufferers, and either *close up* such dwellings, or cause them to be remodelled so as to be fit for human habitations."

But for a long, a very long time, this was only a cry in the wilderness, and tenements continued to spring up without regard to the "essential elements." At last, in the middle seventies, a law was passed by the State legislature restricting uncontrolled tenement construction, and from that time onward progressive changes and laws were made in behalf of tenement improvement; not, however, without various selfish interests interposing hindrances, objecting to the so-called tyrannical socialistic tendencies of tenement legislation, and doing everything possible to counteract the growing tendency for tenement reform. But, in spite of all these, the better elements of society have gained the

upper hand, and the evils of unsanitary tenements have been curtailed in many cities, especially in New York, by the wise and beneficent laws of 1887, 1895, and by the last and crowning model tenement-house law of 1901.

Hand in hand with these beneficial laws are the provisions for their enforcement by the proper municipal departments.

The proper solution of the tenement-house problem is, therefore: Legislation, Restriction, Strict Supervision, Careful Inspection, Constant Vigilance and *the rigid and impartial enforcement of all existing laws now on the statute books;* and last, though not least, the inculcating of habits of personal cleanliness among the masses of the foreign population, who constitute so large a proportion of tenement-house dwellers; for there is no doubt that lazy, indolent, dirty, ignorant or malicious tenants often are as much responsible for the unsanitary conditions existing in tenements as are indifferent, grasping owners or lessees.

CHAPTER II

TENEMENT-HOUSE LEGISLATION AND SUPERVISION

THE problem of housing the poor is not one incident to New York City alone; it applies to all large industrial and commercial centres. It is a burning question wherever large industries are segregated in confined, narrow areas, and wherever modern production creates huge towns with an overcrowded working population. In the United States most of the cities have a housing problem; thus Chicago, Pittsburg, Boston, Buffalo, Philadelphia, and other cities have a more or less large tenement-house population, and the problem of how to limit the further spread of the peculiar conditions incident to tenement-house life engages the minds of the best element in those cities. It is in New York City, however, that the tenement-house problem is in its acutest stage, and has already a history of a half-century of struggles, attempts at improvement, successes, and triumphs.

It is needless to dwell long here upon the peculiar conditions which have made New York City the centre of a huge tenement-house population, and have compressed a two-million populace within the boundaries of one comparatively small island. That New York City was destined to become a typical tenement-house town, and that the evils of the overcrowding were

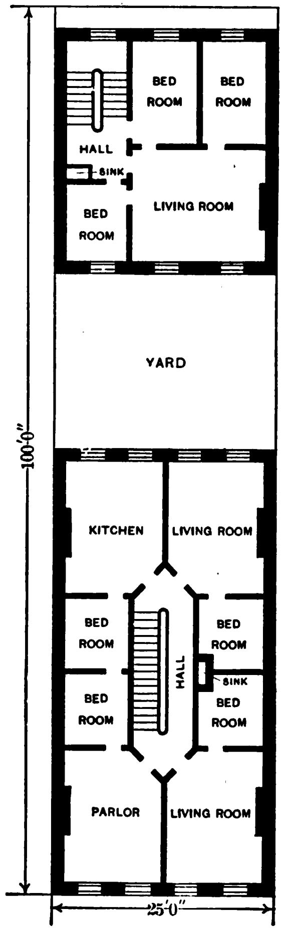


FIG. 21.

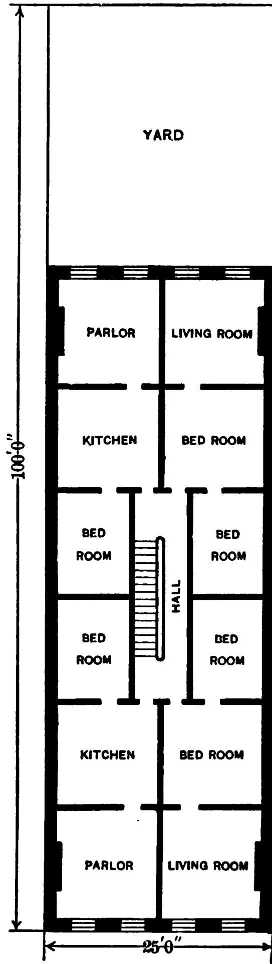


FIG. 22.

1. Front and rear house on one lot.

2. Type of tenement house without light or ventilation, except in outer rooms.

(From Report of the Tenement-house Commission, 1894.)

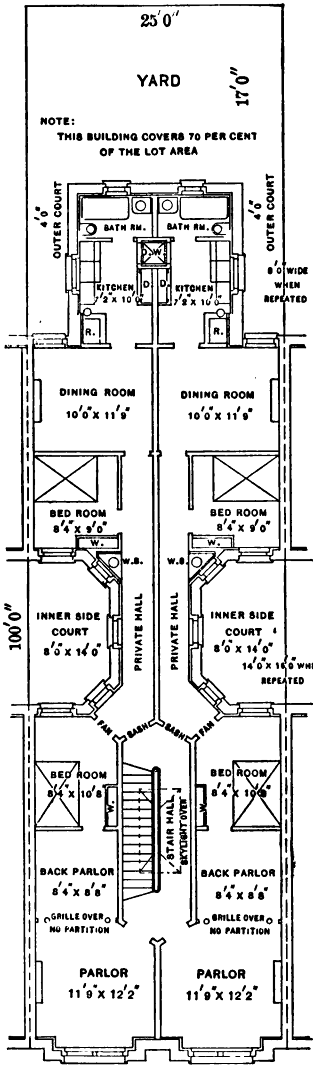


Fig. 23.

Three-story Double-flat.

This diagram, by Harde & Short, shows a structure, 25x70 feet, on a 100-ft. lot. It contains two inner-side courts, 8x14 ft., and two outer courts, 4 ft. wide; windows opening into all the courts.

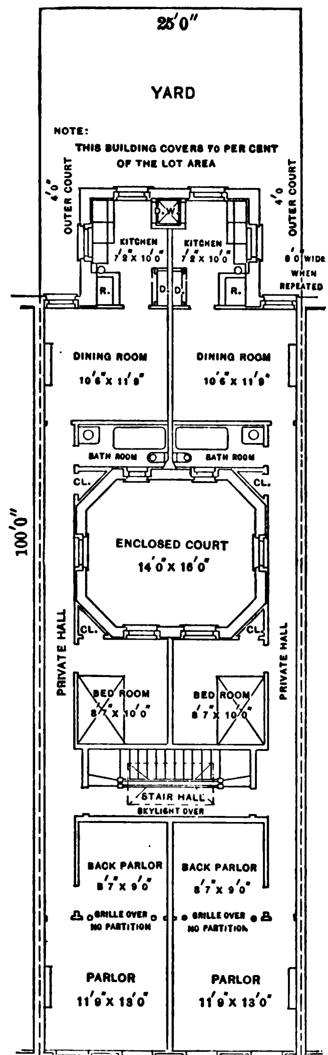


Fig. 24.

Three-story Double Tenement.

This plan is of a building 25x70 feet, on a 100-ft. lot. The inclosed court, with brick wall, is 14x16 ft. Closet room is continued at available points. There are also two 4-ft. wide outer courts. Harde & Short, architects.

bound to increase, was foreseen as early as 1834, when Dr. J. H. Griscom, then City Inspector of the Board of Health, issued a report and "A Brief View of the Sanitary Conditions of the City," in which he outlined the evils of overcrowded unsanitary dwellings, and in which, for the first time, there was urged legislative action to curb the further spread of the growing evil, and to improve the sanitary conditions of the already existing dwellings. Had his words not remained a cry in the wilderness, we should not perhaps have at present a tenement-house problem. But neither Dr. Griscom's report nor the subsequent investigation and movement of the New York Association for the Improvement of the Conditions of the Poor, undertaken in 1846 and 1853, resulted in immediate action; and even after the official legislative investigation of 1856, which disclosed the steadily progressing evils of the neglected tenement-house conditions, nothing was done to improve them. It was thirty-three years from the time of Dr. Griscom's report until the first tenement-house law was enacted; and that was after the most vigorous and the most perfectly organized movement undertaken by the Council of Hygiene in 1864, which at last disclosed conditions which could no longer be ignored.

In 1867 there were 15,000 tenement houses erected without any restrictions or regard for the health or safety or lives of their tenants.

The tenement-house law of 1857, although it was the best legislative enactment for that time, did not solve the problem, and the friends of the tenement-house population did not stop in their agitation and efforts

for the further improvement of those conditions, but at last succeeded in 1879 in having passed a more progressive law in which, among other items, there was for the first time a restriction as to the percentage of the lot to be occupied by a tenement house, a limitation to 65 per cent of the lot-area, which provision was, however, nullified by the discretionary power given to the Board of Health in regard to this percentage. After 1879 the vigorous agitation for further progress did not stop, with the result that there were several legislative investigating committees—in 1884, 1894 and finally in 1900—the labor of which culminated in the tenement-house laws of 1887, 1895, and finally in 1901 in the present Tenement-house Law.

Notable Features of the New York Tenement-house Law of 1901. We cannot here give in detail all the features of the law of 1901, but cite several provisions showing the progressive trend of this last legislative enactment.

The most important and notable features of the law are as follows:

(1) The definite restriction as to the percentage of the lot to be built upon, with stringent provisions as to the minimum size of yards, courts, shafts, rooms, window area, etc., so as to improve materially the light and ventilation of the tenement houses, and make it unprofitable for builders to erect houses on 25-foot front lots.

(2) Increased regard for the safety of tenants in case of fires and the provisions about fire-proof materials and the construction of houses; better and improved forms of fire-escapes; fire-proof stairways, etc.; the

restriction of non-fireproof buildings as to their height and number of stories; the prohibition of the occupation of tenement houses by businesses which are dangerous to life and health, etc.

(3) The regulation of the occupation of cellars and basements, and prohibition of the location in tenement houses of stables, rag-shops, etc.

(4) The abolition of obsolete unsanitary plumbing fixtures like privy-vaults and school-sinks, and provisions as to the compulsory construction of separate water-closets in every apartment; also as to water-supply in new and in old houses.

(5) Many wise provisions for improving the sanitary conditions of tenement houses, and providing for the safety, health, and comfort of their tenants.

(6) Very stringent provisions for driving out prostitution from tenement houses, thus abolishing one of the greatest dangers to the growing population.

(7) The registration of the names of all owners of tenement houses, and the application of the new principle of certification, i.e., that no tenement house newly constructed can be occupied without a previous certificate from the proper department stating that the house was constructed according to the law and is fit for habitation.

(8) The establishment of a separate department to supervise the proper enforcement of all tenement-house laws, and to take charge of all matters concerning the construction and maintenance and sanitary condition of new and old tenement houses, with a proper systematic inspection of all houses and a constant vigilance in all tenement-house matters.

The above are briefly the most notable features of the tenement-house law of 1901, to the progressive provisions of which will be due the improvement in tenement-house conditions in New York as well, it is hoped, as in other cities.

The Organization of the Tenement-house Department. Restrictive legislation is of no value unless proper provision is made for a suitable and strict supervision and enforcement of the legislative enactments. This partly explains why the already existing tenement-house laws in New York were inadequately enforced. Until the establishment of a separate department to care for tenement-house legislation, the enforcement of the existing laws concerning tenement houses was a part of the multitudinous and multifarious duties of the Health Department, which had but an inadequate inspectorial force already overburdened with work. The promoters of the tenement-house legislation of 1900 and 1901 felt that so paramount an interest as the housing conditions of the majority of the metropolitan population deserved a better supervision than can be accorded it by a subdivision of a bureau of a general department, like that of Health, and have therefore urged the establishment of separate municipal machinery to take sole care of tenement houses and to have the sole responsibility for the enforcement of all tenement-house laws. The establishment of a separate Tenement-house Department by the New York Legislature marked an important epoch in the housing legislation of the city and country. The importance of this act cannot be overestimated; and it once and for all gives expression to the deep-rooted conviction that the

proper sanitation of the houses of the working classes is one of the most important duties of municipalities.

The New York Tenement-house Department was first established in January 1, 1902, under the commissionership of the Hon. Robert W. DeForest. He and Laurence Veiller, were the principal sponsors of the tenement-house legislation of that period, and were the chairman and secretary, respectively, of the Tenement-house Commission of 1900.

The department consists of three principal bureaus: The bureau of new buildings, the bureau of inspections, and the bureau of records. The bureau of new buildings has sole charge of the construction of new tenement houses, from the examination and approval of architect's plans through the process of construction to the final certification that the building may be occupied as a tenement house (without which permit not one apartment may be occupied for living purposes). This bureau employs not less than three plan examiners and a number of clerks, draughtsmen, and light, ventilation, and plumbing inspectors. The bureau of inspection takes charge of the inspection of existing houses, either in regular periodical monthly inspections, or upon complaints of citizens of unsanitary conditions in the houses, or upon the occurrence of infectious diseases in the houses. This bureau employs not less than 190 inspectors who are supposed to understand tenement-house sanitation, and who have passed a civil-service examination in regard to it. This inspectorial force is four times greater than the one previously employed by the Health Department for inspection of ALL unsanitary conditions in the city.

The bureau of records provides for a complete system of records regarding each and every tenement house within the city, with records not only of its plans, construction, inspection, etc., but also of every infectious disease, every accident, fire, etc., in the house. Such a system of records is bound to be of priceless value to the future sanitarian.

The splendid achievements of the Tenement-house Department for the first ten years of its existence is the best proof of the wisdom of the framers of the Tenement-house Law, and the advocates of a separate Tenement-house Department.

CHAPTER III

TENEMENT-HOUSE CONSTRUCTION AND SANITATION

CONVENIENCE, strength, and beauty are, according to Vitruvius, the three cardinal principles which should guide the architect in the process of house construction. Unfortunately these are not the guiding principles of modern tenement-house construction, for many of these houses are neither convenient, nor strong, nor beautiful and certainly not comfortable or healthy.

Industrial factors cause the concentration of population in certain overcrowded districts, and tenement-house dwellers cannot, as a rule, choose the location, site, type, class, and character of house they wish to inhabit. There are, however, gradations in the class of what are commonly termed tenement houses. The legislative definition of "tenement-houses" includes all houses which are occupied by three or more families living independently of each other; the legal definition includes all multiple domiciles whether of inferior or of the most modern construction. The popular and generally accepted meaning of "tenement-house," however, differs from the legal one, and applies only to such houses as are of a common and inferior construction, the average monthly rental of which does not exceed $25 and which is inhabited by a poorer class of tenants. While, therefore, adhering to the legal definition of

the term "tenement-house," we exclude in our discussion the more expensive and better-built houses.

Sites. Tenement-house dwellers cannot choose the sites upon which the houses they live in are situated. The same conditions which cause the laboring man to live in the industrial centres of the city also compel him to inhabit houses upon certain streets, blocks, and alleys, without regard to the sanitary requirements of the location of the houses, or, in fact, any other similar considerations. That the ground upon which a house is situated has a great influence upon the health and well-being of the inhabitants has been recognized of old, and is an established dictum of sanitary science. Some sites are rocky, others sandy, others loamy, yet others consist of made and filled-in ground; again, there is ground which is marshy and waterlogged. In towns with extensive river- and sea-fronts, large tracts of the city are situated upon marshy ground; and considerable ground is also regained from the sea and rivers, filled in, and built upon. As a rule, such land is cheaper and therefore is occupied for cheaper sorts of tenement houses, thus compelling a large part of the population to live in houses situated upon wet ground; these houses are, of course, unhealthy and productive of injurious influences upon the health of the inhabitants of their tenants, especially as, owing to cheap and flimsy construction, precautions are rarely or never taken to underdrain the ground, or to isolate the house from the wet soil upon which it stands.

Construction. The prevalent method of tenement-house construction is the building up of the entire street frontage, leaving but a small (10 to 20 per cent)

unoccupied space in the rear of the house. These so-called "attached" houses are a special feature of New York tenement-house construction, with the result that whole blocks are solidly built upon except for a narrow space in the middle of the block formed by the yards in the rear of houses. At times these unoccupied spaces do not form more than 10 per cent of the whole area of the block. The tendency of modern legislation is to restrict as much as possible the area of the lot built upon, thus increasing the area available for breathing purposes. There has been no attempt as yet at legislative enactments prohibiting or curbing the system of attached house construction and insisting upon detached or semi-attached construction, although many individual builders have tried the latter form of construction and found it not only more healthful for the occupants, but also productive of financial rewards. Of course, the wider the streets, the larger the yard, the more spacious the courts and areas surrounding and included in the houses, the more light and ventilation there is available for the occupants of the house, and the healthier the houses of such construction are.

The Materials of Construction. The materials from which a house is built form an important item in sanitary as well as other respects; the present tendency is to discourage the construction of frame buildings, especially in large cities, and to build tenement houses of stone and brick, with iron beams in one or more stories of the house. There are many grades and qualities of building brick, speculative builders preferring, of course, the cheaper and inferior, as well

as old and second-hand kinds. The building regulations of most municipalities prescribe in detail the kind and qualities of material to be used, but the conformation of the builders to the law depends upon careful supervision and enforcement by the building inspectors. The rigid enforcement of laws concerning construction is one of the most important municipal duties, and should be entrusted to competent, expert, reliable, and *well-paid* men. The frequent accidents involving frightful risk to limb and life, and due to faulty construction and bad material, prove over and over again that municipalities cannot overlook this most important part of municipal sanitation, nor can they afford to save on the character and compensation of their employees.

The restriction of the height of buildings is a necessity, and has been practised since the days of Augustus. In overcrowded areas and in narrow streets the height of houses should be carefully supervised and restricted, and the provision of the New York Tenement-house Law restricting the height of tenement houses to one and one-half times the width of the streets on which they are situated is a wise one, and will tend to discourage the construction of 6- and 7-story houses upon narrow streets; another salutary provision is the one making the construction of high houses more expensive by the provision that all houses above six stories in height must be fireproof throughout.

Foundations. Not only the stability but also the healthfulness of a house depends upon the proper construction of the foundations. The methods of constructing the foundations depend largely upon the

character of the ground upon which the house stands. In marshy, waterlogged, boggy, and filled-in land it is necessary to drive piles into the soft soil and then prepare a solid bed of concrete upon them with proper provision for damp- and water-proofing by the use of sheet lead, slate, asphalt, or tar. Not only the footings in the foundation walls but the entire lower story of the house should be completely isolated from the ground by damp-proof materials, so as to prevent effectually dampness from being drawn into the house walls. While some sort of damp-proofing, very faultily applied, is put into new houses, there are a very large number of tenement houses built in pre-restrictive times which have no provision for damp-proofing whatever, although they are situated directly upon watercourses, filled-in ground, or tide-ridden soil, with the result that these houses are damp and wet, and unhealthy to inhabit. This brings us to the important subject of house-dampness and water in cellars, which deserves a more extended discussion.

House-dampness and Water in Cellars. *Causes of House-dampness.* The causes of dampness in houses may be those due to conditions existing above the cellar, or those in and under the cellar. Dampness above the cellar may be due to the following causes:

(1) Porosity of building materials.

(2) Water from various sources coming in contact with house.

(3) Defects in construction and maintenance.

(4) Occupation, uses, and abuses of the house.

(5) Capillary attraction from the ground and cellar.

The Porosity of the Various Building Materials. The nature of most materials of which houses are built renders it possible for the latter to be damp. Wood, brick, mortar, and even stone, are all porous and absorbent, and are capable of retaining a large quantity of water for some time. Lumber when unseasoned contains a very large percentage of water, estimated by some to reach 50 and even 60 per cent of their weight; even thoroughly seasoned and dried wood still contains about 20 per cent of moisture. Brick, which is so extensively employed as a building material, possesses a considerable absorbent power, estimated at from 10 to 30 per cent according to the quality of the brick. A brick that absorbs only 10 per cent of moisture is considered good. It was calculated by Eassie that an ordinary brick absorbs about half a pint of water. Brick walls, therefore, are capable of absorbing and retaining very large quantities of water.

Mortar which is used to bind brick, and the quantity of which in buildings amounts to nearly one-third of the brick surface, is still more absorbent than brick. Mortar is a mixture of sand with lime or cement. Common lime mortar absorbs from 50 to 60 per cent of its own weight, and the best Portland-cement mortar absorbs from 10 to 20 per cent.

All stones, even the most dense granites, are more or less porous and possess the power of absorbing water. A cubic foot of ordinary stone will absorb from 5 to 10 lbs. of water.

It is evident, therefore, that the porosity of building materials alone is a potent cause of house-dampness,

and this becomes more evident when combined with the other causes enumerated above.

Water from Various Sources coming in Contact with Walls and Ceilings. We now know that the materials from which the house is constructed are absorbent, and the factors of dampness which we are to consider are the causes of water coming in contact with the house. As a matter of fact these causes are very numerous. From the time the materials are gathered at their original sources, and during all the time they are a part of the house, they are repeatedly and frequently wetted and watered. During construction large quantities of water are purposely incorporated in the mortar and the bricks, besides the water due to the occasional rain-storms wetting the whole building under construction. The practice of builders of hurrying with the plastering, ornamenting, and the painting of the walls inside and outside is also a cause of dampness, as the large quantity of water in the materials is thus prevented from evaporating. Even after the house is built there are numerous sources of water coming in contact with the walls and ceilings of house; thus, the occasional driving rains wetting the walls, and the other occasions enumerated below, help to render the house damp.

Defects in House Construction and Maintenance. Defective, too absorbent materials, hasty construction, too early plastering and painting have been mentioned before as causes of house-dampness; the further causes are the defects in maintenance, such as leaky roofs, bad rain-leaders, faulty eaves, gutters, etc., all causing large quantities of water to come in contact

with the walls or ceilings and rendering the house damp.

Occupation, Uses, and Abuses of House. Besides all the causes enumerated there are others that help to increase the moisture within the house; thus the very occupation of the house, the moisture produced by the occupants, by the illuminants, and by the heating, as well as by the abuse of water on the floors and walls, overflowing of basins, steam produced in kitchens, laundries, and bath-rooms, and other uses of water in the house.

The Capillary Attraction from the Ground is another and very potent cause of damp houses, as all water within the cellar and lower part of house is drawn up by capillary attraction into the walls, and the causes of the cellars being wet and damp are very numerous, as will be seen immediately.

Sources of Water in Cellars. The following is a classification of the various sources of water in cellars:

I. NATURAL SOURCES

Surface-water.—Location of house.
Proximity of adjoining ground.
Condition of surrounding ground.

Subsoil-water.—Ground-water.
Underground lakes, streams, and ponds.
Underground springs and ponds.

Tide-water.—Coming through the ground.
Coming through sewer pipes.

II. ARTIFICIAL SOURCES

Water-service Leaks.—Street mains.
House mains.
Yard and dead pipes.

Sewage-water.—Permeability of sewers.
Street and private sewers.
House and yard drains.
Cesspools, privies, school-sinks, etc.

Manufacture and Storage.—Manufacture of mineral waters.
Storage of ice, etc.
Overflow from various fixtures.

The enumerated sources of water in cellars may exist in a house singly or in combination, and cause the cellars, subcellars, and walls of the lower story of the house to be damp, which dampness may be drawn up by capillary attraction into the walls of the upper stories of the house.

The examination for the sources of the water in cellars is sometimes a very difficult matter, demanding ingenuity, practical knowledge, and experience on the part of inspectors.

Prevention of House-dampness and Water in Cellars. The prevention of the dampness in houses and of water in cellars may be palliative or radical. The radical means of prevention are twofold: (1st) The removal of the cause or causes of the dampness and water, and (2d) the construction of the house so as to

keep dampness and water out. The palliative means of preventing dampness and water from gaining access into houses are: (1st) The scraping off and drying of all walls and ceilings infected with dampness, and (2d) the coating of the walls and ceilings with damp-proof materials.

The removal of the causes of dampness and water in cellars is the best prevention against the evil, and may consist in the following procedures:

(1) Selection of non-porous, dry, and well-seasoned building materials.

(2) Location of the house upon a dry, well-drained site.

(3) Thorough drying of the newly constructed house before occupation.

(4) Proper construction of walls, ceilings, roofs, gutters, window-sills, etc.

(5) Careful use of water within the building.

(6) Proper heating and ventilation of the rooms before and during occupation.

(7) Prevention of any and all defects caused by the leaks from various sources.

The art of constructing a house so as to prevent dampness from entering is within the province of the important science of architecture, and cannot be gone into here.

Interior Decoration. The proper finishing of floors, walls, and ceilings is not without importance to the health of the occupants of the building.

Floors are made of narrow or wide planks well fitted together. Such flooring, especially when the planks are narrow, is better than the mud and rush floors used by our forefathers; there is, however, still much room

for improvement, for the reason that such flooring easily cracks, the spaces between the individual planks become wider and wider with the drying of the wood, and are filled in with dust, dirt, and decomposed vegetable and animal matter. Such a floor it is almost impossible to keep clean, and it has been proven that, owing to its periodical and frequent wetting, many pathogenic germs may thrive in the cracks and spaces. The growing practice of covering the floor with oilcloth and linoleum is to be encouraged, although a hard-wood flooring or a stone-tile floor is the best in sanitary respects. For halls and for bath-room and water-closet apartments of tenement houses a tiled or slate floor should be insisted upon; the same for stairs, as there is nothing more dusty and unsanitary than a carpeted stairway.

Walls and Ceilings should be covered with a hard, smooth, easily washed, light paint; papering the walls and ceilings is unhygienic on account of the difficulty of cleaning and washing it, and the growing practice of covering walls of halls in tenement houses with burlap is bad and should be discouraged, as the burlap has a rough surface and cannot be properly cleaned; moreover, being expensive, it is not changed for years. Metal-covered ceilings and walls of halls are good, and have been extensively introduced in newly built tenement houses, especially in stores and halls. The New York Tenement-house Law of 1901 contains a provision prohibiting putting new paper on the ceilings and walls of rooms in tenement houses unless the old paper is first removed. This provision of the law is, however, a dead letter, and hardly ever enforced owing

to the expense of the procedure and the reluctance of owners to spend the additional sum for the removal of the old paper, and also to the utter impossibility of municipal supervision of the action of individual paper-hangers. Kalsomining of ceilings and walls is advocated by some for the reason that it is very cheap and can be repeated very frequently, and also for the reason that carbonate of lime acts as a disinfectant.

Light, Heating, and Ventilation. *Light.* One of the greatest of the evils of the tenement-house system is the complete or semi-darkness of most of the rooms in the apartments—a condition which leads to bad health and danger to life and limb. The prevailing mode of tenement construction does not provide for the natural lighting of all the rooms, and with the 25×100 lot it is rather difficult to provide every room with windows into the outer air. Most of the older tenement houses have been built with practically but two light rooms in each apartment, i.e., the rooms at the front and rear of the house, leaving all the middle rooms in entire darkness. With the advent of the dumb-bell-shaped houses the middle rooms received light from the narrow air-shafts; these have been ordered to be widened with every new legislative tenement-house enactment, until, at present, the New York law provides for the entire abolition of dark rooms and narrow air-shafts, according to which law even bath-rooms must have windows into the outer air. Thus the fight against the powers of darkness has been won after many years of agitation and struggle. The most potent cause, however, of the dark rooms and insufficiency of light in halls, etc., lies in the peculiar method of lot division

prevalent in New York City, and the prevalent methods of building houses attached and close to each other. With semi- or completely detached houses provision may be had for lighting the house from all sides instead of from the front and rear of the house only, as heretofore.

So far as artificial lighting of halls and rooms is concerned, some progress has been made of late. The New York law provided for the compulsory lighting of all halls from sunset till 10 P.M., and of two halls the whole night through; there is also a provision compelling the owners of houses the halls of which are dark in the daytime to keep a light burning the whole day. Unfortunately no municipal department can possibly have so many inspectors as to secure the enforcement of this law, hence the result that the lighting provision of the law is but a dead letter.

Heating. The prevalent method of heating tenement houses is still the old one of using stoves and ranges in each apartment, although many houses are now built with provisions for steam-heat and hot-water supply. So far as convenience is concerned steam-heating is certainly better than the old way of individual heating by stoves; but hygienically speaking it is to be doubted whether steam-heating is the better mode of the two. The disadvantages of steam-heating are the following: (1) the oppressive heat given by steam-pipes under high pressure; (2) the irregularity in the provision of the heat, depending upon the ability, honesty, regularity, and competence of the janitors; and (3) the difficulty of regulating the degree of temperature suitable to each individual tenant of the

house. Heating by furnaces is applicable only to small houses, and is hardly ever used in tenement houses; the same may be said of heating by hot-water pipes, which is the best and most hygienic form of heating rooms and houses. Whatever the methods employed for heating rooms, the halls should be provided with a warming-plant.

Ventilation. No special provisions are made, as a rule, for ventilating the rooms and halls of tenement houses, except by means of the windows, transoms, and doors in each room and in the halls. The halls are provided with additional means of ventilation, either by scuttles or by the louvred skylights. The openings from every room into the chimneys are of course additional means of ventilating the rooms, especially in winter when the rooms are heated. Ordinarily the above means of ventilation ought to be adequate for the purpose, but when the rooms are overcrowded and doors and windows hermetically closed, as is often the case in most tenement houses the air within the rooms is apt to become foul and vitiated. There is certainly great need of popular education on the boon of fresh air. There are many tenement houses where there are a number of rooms without any windows whatever, and the ventilation of such houses is very bad. However, the days of these houses are numbered, as the laws are more stringent and require such rooms to be vacated, or provided with windows into the outer air. Cellars are ventilated by windows, gratings, and doors. Water-closets and bath-rooms need ample ventilation, although these rooms have been, as a rule, neglected hitherto.

The New York Tenement-house Law makes strict provisions for the ventilation and lighting of these rooms. The increased area of the yards, courts, and other unbuilt spaces adds much to the ventilation of the rooms of the house. The minimum air-space set by the Tenement-house Law is 400 cubic feet for adults, and 200 for children under twelve years of age. This minimum is not adequate and should at least be doubled.

The extension of the public park and playground system, especially in crowded tenement-house districts, is a great boon to tenement dwellers, as these open-air spots increase the breathing-spaces in those districts and are veritable oases in the tenement Saharas.

Water-supply. Owners of houses are compelled to furnish an adequate supply of water for all domestic purposes, and each and every floor must be provided with proper fixtures to distribute it. In some old houses the main water-service pipe, originally intended for one family, is made to serve for a number of families, and is inadequate, not being sufficient to supply water to the upper floors. The remedy is a water-pipe of larger size. In houses of 4 or more stories the ordinary street pressure is not sufficient to raise the water to the upper floors, and it is then necessary to instal gas-, gasoline-, or steam-engines to pump water into tanks above the highest floor, whence it is supplied to the upper floors. These tanks may become a source of nuisance, as they may leak and cause dampness of the ceilings of the upper story, or furnish dirty water from sediments and dirt gaining access thereto. Tanks should be properly constructed, water-tight, well covered, accessible, easily cleaned, and frequently emptied,

scrubbed and cleaned. The overflow from the tank must not discharge into the rain-leader, or into other house-pipes, but should be led down into the cellar to discharge into a sink. The washers on the water-faucets must be renewed once in a while to prevent leakage.

Plumbing. The plumbing of a tenement house does not differ from the house-plumbing described in the first part, except in so far as the tenement houses are built for poor people and all the materials, plumbing included, are of inferior grades, and the workmanship cheaper and inferior.

One of the most dangerous defects in tenement-house plumbing is the old brick or earthenware house-drains. These drains are too large, laid without any fall, and situated underground, with the joints unsupported and broken, and with great holes here and there—altogether channels of indescribable filth, giving off miasmatic effluvia, saturating the cellar-ground with liquid sewage, poisoning the air in cellar and house, and causing disease and pestilence. Whenever such drains are found they should be ordered out, as even the best of them are not without danger, and the law now prohibits any but extra heavy iron pipe-drains in houses. There is scarcely an earthenware house-drain that will stand a properly applied test.

The iron house-drains in tenements are often underground, owing to the presence of fixtures in the cellar; in such cases an examination of the house-drain is not possible without a test. Plumbers in cleaning house-drains of obstructions are in the habit of leaving open holes in the drains, or, if they take the trouble to close the holes, they do so with sheet-metal, putty, or cement,

or sometimes with only a rag tied around the pipe. These openings are a means of escape for sewer-air. They should be closed gas-tight with iron bands, patent saddle-hubs, or screw-nuts. The covers of the handholes of traps on house-drains should be adjusted so as to be gas-tight. Very frequently there will be found connected with the house-drain the overflow pipes from refrigerators, roof-tanks, waste-pipes from stores, pressure-pumps from beer-saloons, etc. All such pipes must be disconnected from the house-drain, the opening at the disconnected place closed and made gas-tight, and the waste-pipes made to discharge into a sewer-connected, properly-trapped, water-supplied open sink.

Sinks and water-closets are often found in cellars, and, apart from the fact that such fixtures ought never to have been put there, they are hardly ever used, and, their seals having evaporated, allow sewer-gas to enter the cellar through the empty trap. Such disused fixtures should be disconnected and removed.

Traps of fixtures are not yet vented in every house, hence siphonage is rather a common occurrence. The soil- and main waste-pipes are not always extended above the roof, and, when, extended are often fitted with return-bends and cowls. A common defect in tenement-house plumbing is the improper joint-connection of pipes, putty and cement joints being frequent. In some houses the traps are of quite an antiquated form, bottle and other old traps being occasionally found. Holes in traps, in waste-pipes, and in all other pipes, abound, and are either left open or are closed with putty, dough, or rags. The sinks have woodwork enclosing them underneath, the spaces within these

enclosures being exceedingly foul and filthy. Water-closets are the most abused fixtures in the house: So many people use, so many more abuse, and so few clean them, it is no wonder at all that water-closets are masses of filth and that they poison the air. In some houses the water-closets are situated in cellars. Of school-sinks I have already spoken. The long Philadelphia hopper closets, those especially with a spiral flush, are a nuisance, as they are never clean, nor well flushed. Pan closets are not so frequent in tenements, thanks to sanitary inspectors, who order them out as soon as they discover them.

There are a great many ways in which plumbing may be defective, as we have seen in Part I, and the only remedy is to be constantly on guard, inspect the plumbing frequently, and have it put in proper condition by licensed plumbers.

Condition. No matter how well constructed the tenement house may be, if, after construction, the house is not properly taken care of, it will become dilapidated, filthy and offensive. A strict supervision over and care of the yard, fixtures, etc., are essential to the house being fit to live in, and therefore the law calls not only for proper cleaning of the house and its several parts, but also demands that, in each and every tenement house, there shall reside a housekeeper, whose sole duty it shall be to take care of the house, clean all its parts, and exercise supervision over it.

Yards in tenement houses are usually very small, and are greatly abused. In a space of 10–12×25 feet will often be found the yard hoppers or school-sink; and the space is filled by the inevitable clothes-lines.

The yard should be properly cemented or flagged, and so graded as to discharge all surface-water into a properly-trapped, sewer-connected, drain. The yard should be swept clean, and kept free from rubbish.

The Air-shafts, Courts, and Areas should be properly paved, graded, and drained, and should be kept clean. The fresh-air inlet in the front area, or in the front sidewalk, should be kept clear of all obstructions.

The Cellar. Even the best-constructed cellar will become offensive if not properly taken care of. The floor of the cellar should not be broken, as the holes become receptacles for dirt, and the walls and ceiling should be whitewashed or painted frequently. The cellar-floor is to be drained when the house-drain is underground, the drain to be trapped with a siphon trap provided with very deep seal to prevent evaporation. The cellar should be cleaned of all offensive refuse and rubbish, and be frequently disinfected.

The Halls of tenements are, as a rule, dark and dreary, dimly lighted by day, and little more so by night. The New York law relating to lights at night in halls is as follows:

> "In every tenement house a proper light shall be kept burning by the owner in the public hallways, near the stairs, upon the entrance floor, and upon the second floor above the entrance floor of said house, every night from sunset to sunrise throughout the year, and upon all other floors from sunset till 10 P.M."

The rails and balusters of stairs should be secure and in good repair, and the wainscoting and floors of the halls should be well kept and frequently scrubbed and cleaned. The practice of papering the walls of halls is pernicious, a light-colored paint being the best covering

over walls and ceilings of halls, as well as of water-closet apartments.

The Water-closet Apartment should be well looked after, as it is the place most likely to be dirty in a tenement house. The floor should be clean, and must be of an impervious material. The floor, seats, walls, ceilings, windows, etc., should be frequently cleaned.

The Roofs of tenement houses require great care, and should be clean and free from defects and leaks. Guard-rails should protect the roof on all sides, and the eaves-gutters should be in good repair and tight; the whole roof should be painted once a year. The chimney, pipes, and tank on the roof should also be kept in good condition.

The Plumbing Fixtures have often been alluded to, and nothing remains but to emphasize the fact that, of all parts of the house, the plumbing and plumbing fixtures must be most constantly watched, in order that all defects may be promptly repaired, and cleanliness exercised to the utmost degree.

The rooms should be clean, the walls and ceilings painted, and the floors scrubbed; the windows should be easily opened and cleaned, and often left open to change the air in the rooms.

CHAPTER IV

PRIVATE DWELLINGS

HOUSES built for one or two families are, as a rule, of better construction than tenement houses, but there is a large number of old houses which were built years ago, and which are in a bad sanitary condition, that are used as private dwellings.

The points especially to be looked after by the inspector examining private dwellings are the cellar and the plumbing.

The cellar is, as a rule, large and spacious, but is usually filled with rubbish and refuse, and the floor is rarely a cemented one. The antiquated hot-air furnace so often found in the cellars of private houses is a cause of frequent complaint, as it is hardly ever in good order, is badly constructed, the joints not being tight, the flues and air-conduits defective, the cold-air box in the wrong place, and the whole a source of smoke and coal-gas. The servants' closet (usually an old pan closet) is located in the cellar; the house-drain is underground, and either of earthenware or of brick. The cellar, as a whole, is a repository for sewer-air and a breeding-place for disease germs.

The plumbing in old private houses is sometimes so complicated and so full of defects that it is at times a matter of difficulty to examine it. The reason for

this is that these old houses have been subjected to the bungling of several generations of plumbers, each trying to remedy certain evils, but instead adding to them by some new complicated " by-pass," connection, etc. The wash-basins in the many bedrooms may be a convenience, but they are certainly additional means of allowing sewer-air to enter the house. These wash-basins are all over the house, irrespective of the location of the main waste-pipe, and consequently require the running of long, horizontal, lead branch-pipes under the floor, with the likelihood of these being gnawed by rats and broken into by nails. The wash-basins are also left unused for long periods, and the traps consequently lose their water-seal by evaporation, thus permitting the escape of sewer-air from the drain. Vent-pipes are not often found, and siphoning is frequent. Private dwellings are the places where the pan water-closet is still frequently found; nor is the extension of vertical pipes the rule in these old houses.

Altogether the sanitary condition of many old dwellings is deplorable; and as the municipal authorities are mostly occupied with looking after tenement houses, the private dwellings receive little or no attention unless some disease breaks out, or some tenant has the courage to complain to the proper department.

SECTION II.—OCCUPATIONS AND TRADES

CHAPTER I

FACTORIES AND WORKSHOPS

FACTORIES are places where work is done with the aid of mechanical power, while a workshop is a place where work is done without the aid of any mechanical power; thus, a tailor shop with machines run by hand or foot is a workshop, while shops where the machines are run by steam or electricity are to be designated as factories. This is the differentiation and definition of the terms as accepted in England, although the New York State Law reads " the term factory shall be construed to include also any mill, workshop, or other manufacturing or business establishment where one or more persons are employed at labor."

A great part of the workingman's life is spent in the workshop or factory, and the sanitary condition of the place of work is of great importance to the health and well-being of the workingman. The proper construction, lighting, ventilation, plumbing, and cleanliness of the place of work affect the health and life of the worker, and are therefore subjects of great importance to the sanitarian.

The Construction of Factories and Workshops. All industrial establishments should be specially constructed for the specific purposes for which they are to be used; and the usual plan of adapting any ramshackle, out-of-date building, unfit for any other purpose, to the uses of a factory or workshop, as frequently is the case, should be legislatively prohibited. All factory construction should be done under the strict supervision of the labor and factory authorities, who should issue a permit for occupation only after thorough inspection and conviction that the building is fit for the purposes for which it is constructed.

The size of the work place should, of course, be proportional to the number of employees and to the needs of each establishment. The legal minimum of four hundred cubic feet of space for each worker, established by several legislatures, is entirely inadequate; there should be at least 1000 cubic feet of space for each individual, as a general rule, and this allowance should be increased in especially dusty or otherwise dangerous trades. The walls, ceilings, floors, and all surfaces of work places should be constructed with special regard to the industry carried on. Thus, in all places where large quantities of dust abound, the walls and especially the floors should be made of a smooth material, such as glass, tiling, etc., which can easily be washed and scrubbed; and all nooks, corners, crevices, etc., where dust may accumulate, should be avoided. In all places where the humidity of air is above the average, the walls, ceilings, and floors should be made of impervious, non-absorbent material. Wherever possible, the floors should be made of concrete and

cement, or asphalt, or of tile and stone materials; and wherever large quantities of water may be spilled upon the floors these should be so graded and drained as to discharge all the water into special pipes, not, however, connected with the general plumbing system of the house.

Lighting. On the proper lighting of factories and workshops depend not only the condition of the eyesight of the workers but their general good health. Shops should have ample window area, such area to be at least 20 per cent of the superficial area of the room, and so distributed as to give proper and ample light in all parts of the workroom. There is nothing so conducive to ill health and occupational disease as dark and dingy workrooms, which no doubt play an important rôle in the prevalence of tubercular diseases among various workers. The ideal factory and work place is that in which no work is done except by daylight, but as this is not always possible, the artificial lighting of work places is a matter of great importance. The best illuminant is, of course, electricity, which not only gives a better and stronger light but also adds no impurities to the air nor raises the temperature of the place. The lights next best to electricity are the white lights given by Welsbach and kindred burners; they should not be placed too near the persons of the workers, and should be uniformly distributed.

Plumbing. The plumbing pipes and fixtures of factories and workshops do not differ essentially from those in tenement houses and other dwellings. There should be ample wash-rooms, urinals, and water-closets on every floor in every work place; these fixtures

should be of the best and most modern type, and should be under the constant and especial care of proper persons, for where there are a large number of persons using these fixtures they are liable to be abused. The factory laws of most states demand separate wash-room and toilet accommodations for male and female employees.

Preventions of Accidents. The best mode of preventing accidents in work places is to have the machinery, etc., properly safeguarded, also by properly drilling the employees and educating them in the proper handling of the various tools and machinery and in the best methods of self-protection. Motor engines, fly-wheels, etc., as well as hoists and elevator shafts should be properly fenced in and guarded; wheels, shafts, drums, belts, and all gearing, circular saws, planes, power looms, and all other machinery should be properly safeguarded so as to protect the worker from possible injury. Inexperienced persons, women, and children should not be allowed to handle and work near dangerous machinery, So far as the proper maintenance of the work places is concerned, this demands the special care of proper persons, and should not be left to the workers themselves, as upon the proper cleaning, washing, and disinfecting of workshops, etc., depend the health and well-being of the workers, and as the law compels janitors to be engaged for tenement houses, there is still more ample reason to require factories, where hundreds of persons are working, to be kept clean and in good sanitary condition by special caretakers.

Home Work. The carrying on of manufacture and work at the home of the operatives instead of at the shop

and factory is an evil from which many industries and many cities are great sufferers. This so-called "sweat-shop" work is especially prevalent in the clothing industries, and wherever there is a large foreign working population in big cities. Not so long ago home work was also prevalent in the tobacco and cigar industries. There are a great many dangers following and accompanying sweat-shop work: (1) the tendency to child and female labor, as home work is either carried on by the father of the family assisted by his wife and children, or is exclusively in the hands of the mother and children with the usual baneful result of female- and child-labor on their organisms; (2) the unsanitary condition of the living rooms owing to the dust and débris from the work, the insufficient ventilation, and the dirt incident to home work; (3) the danger of infecting the homes of the workers, or of carrying out and spreading infection from their homes through the material and products of manufacture. There should certainly be a complete separation of home from factory, the home not to be used for any but its legitimate purposes, while all work should be carried on in places specially constructed and fitted for it.

CHAPTER II

VENTILATION OF FACTORIES AND WORKSHOPS

THE health and well-being, as well as labor-efficiency, of operatives depend upon the state and purity of the air in the workshops and factories. Where comparatively small rooms are used by a great number of employees, it is evident that the air of the work place will soon become greatly deteriorated, and so foul as to constitute a menace to the health of the working people breathing the impure and foul air. In order to reduce the dangers and to remove the impurities from the air of factories, etc., efficient ventilation becomes necessary.

Deterioration of Air in Industrial Establishments. This is due to:

I. *The Presence of the Workers:* Their breathing causing a decrease of oxygen, increase in the relative amount of carbonic acid, increase in the amount of moisture, increase of temperature, and increase in the relative amount of organic matter in the air.

II. *The Condition of the Place of Work:* Detritus from walls, floor, ceilings, and other surfaces; increased humidity due to the dampness of walls and other parts of the building; moulds, fungi, and other low forms of organic life, causing deterioration of the air.

III. *The Artificial Lighting and the Heating of Rooms:* Causing increase in the relative amount of carbonic acid in the air and an increase in temperature.

IV. *The Machinery, etc.:* Increase of temperature from the motion and friction of machinery, etc., and waste and detritus from tools, stones, machinery, etc.

V. *The Industrial Processes:* Waste from the crude materials which are torn, crushed, ground, milled, polished, etc.; dust from the organic and inorganic substances of manufacture; poisons, fumes, and gases, infective agents, bacteria, etc.

The above-named causes of deterioration in the air can be removed by ventilation, either natural, artificial, or mechanical.

Ventilation through the pores in the walls and building materials and by the additional means of the ordinary openings made in the building, such as windows, transoms, and doors, may be adequate for very small workshops with a very limited number of workers, but will be inadequate for larger shops and manufactories. Nor will the special artificial openings made for ventilating purposes, such as special outlets, chimney flues, cowls, and other arrangements mentioned in the chapter on ventilation in the early part of this book, prove sufficient for the thorough and adequate removal of all the many impurities which abound in the larger workshops and factories; certainly they will be utterly insufficient where dust, gas, and noxious fumes are produced in the processes of manufacture and industry. In such cases we cannot depend upon the ordinary means of ventilation, but must have recourse to the system of so-called "artificial" ventilation, which should rather be termed "mechanical" ventilation.

Mechanical Ventilation. Mechanical ventilation consists of removing the vitiated air from a place or of

forcing fresh air into a place, or both, by means of mechanical contrivances and with the aid of motors run by steam, electricity, compressed air, etc. These methods are termed *vacuum* or *extraction*, and *plenum* or *propulsion* ventilation. Both systems, as well as combinations of the two systems work by means of fans run by some motor power, the fans being so constructed that they either exhaust the air from the room or force outside air into the room, according to the construction of the blades of the fan.

Besides the simple expedient of exhausting the foul air or providing fresh air, mechanical ventilation has the advantage that in the propulsion method additional means may be provided for warming the incoming air to a desired temperature, and also for regulating its relative humidity. In the extraction method means may be provided for collecting the impurities of the extracted air in proper receptacles, for clearing the air of dust, etc., by filtration, precipitation, or compression, and for the absorption of gases, etc., by chemical means.

Ventilation by fans, by which is meant mechanical ventilation, has very great advantages over all other methods of ventilation, and should be resorted to in all large industrial establishments where there are a great number of workers, and where the processes of industry develop large quantities of various impurities. Ventilation by fans can be easily installed in any industrial establishment where some motor power, such as compressed air, steam, or electricity, may be conveniently had. Not only are the quantities of air which may be supplied by fans practically unlimited

and the supply under perfect control, and not only may provisions be made, as stated above, for warming the air and removing dust, etc., but there is the additional advantage of the possibility of removing the dust, fumes, etc., at the *very point* where they are given off. This is an absolute necessity in some industries where the amount of dust given off or the fumes generated would be injurious to health if not promptly removed.

The proper ventilating devices for removal of dust consist of the following:

(1) an expansion hood, box, or cap, properly fitting or enclosing the tool, machine, or stand of each dust-producing process or worker;

(2) tubes or ducts connecting with the above-named hoods, etc., and leading to the outlets;

(3) the fans proper, which are at the ends of the outlet, tubes, or ducts, and which serve to exhaust and extract the air with the dust from the tubes and hoods, etc.; and

(4) receptacles into which the dust settles by gravitation, centrifugal motion, etc., after it is extracted. Various other appliances, such as those for wetting the air, etc., may be connected with the apparatus.

For purposes of general ventilation the exhaust or propelling fans may be placed in one or two parts of the building without regard to local ventilation of the individual industrial processes. It is needless to say that the installation of a ventilating apparatus demands proper engineering knowledge and skill, and a detailed calculation of the various conditions arising in the process.

CHAPTER III

INSPECTION OF FACTORIES AND WORKSHOPS

THE sanitary inspection of factories and workshops does not differ in general from the sanitary inspection of dwellings, etc., except in so far as there are a great many items of inspection not found in other establishments. The principal groups of points of inspection can be divided as follows:

I. *Place of Work.* Construction of shop, its lighting, ventilation, plumbing, maintenance, etc.

II. *The Workers.* Numbers, males and females, children, etc., licenses, etc.

III. *The Processes of Work.* Character of industry, manner of work, machinery, dust, etc.

IV. *Protection against Accidents.* Elevators, hoists, machinery, boilers, etc. A proper inspection of an industrial establishment embraces a detailed and thorough inspection of all the various points as indicated below in the example of an official report of inspection by the New York Bureau of Labor:

REPORT OF INSPECTION

Street and number..
Date of inspection..
Name of person, licensee, firm, or corporation.....................
[If establishment has removed or there is a change of name, so state]

....
....

If incorporated or joint-stock concern, give president's name.........
....
Name and address of owner, agent, or lessee of building.............
....
Number of stories?.................. Floors occupied?...........
Building used wholly for manufacturing or business purposes?........
Goods made or work done?..
Principal material used?..
If made in front or rear shop, state whether by *piece*, *contract*, or *sub-contract?*..................... Custom or ready-made?.........
For whom?...
Number of owners or proprietors at work?..........................

EMPLOYEES. (Exclusive of Working Proprietors, Managers, etc.)	OfficeHelp, Messengers, etc.	In the Workshops.	Total Number Employed.	Regular Weekly Hours of Labor in Workshops
Males 18 years old or over....	....	....	....	....
" under 18 years........	....	....	....	....
Females....................	....	....	....	....
Children 14–16 years* Boys	....	....	....	} ....
Children 14–16 years* Girls	....	....	....	
" under 14 years......	....	....	....	X
" illiterate...........	....	....	....	X
Largest number of employees at any time in year past.....	....	....	....	X

* Children are also to be included in number of Males and Females.

Board of Health Certificates—Are they filed?..................
How many missing?................ Is record kept?...........
Hours of Labor—Is notice posted as to hours for males 16–18 years old and women?........ For children under 16?............ Do children work more than 9 hours in any day?......... If former work more than 16 hours in any day, state reason................
....
Was inspector notified of change in hours of labor?...............
Is overtime record kept?........................... Do either class work nights (9 P.M.–6 A.M.)? ....
Meal Time—Time for noonday meal?..........................
Has permit been granted?... Is it continued?... Is it posted?...
If overtime be required, how much time for lunch?...............

Wages—If incorporated or joint-stock concern, how often are employees paid?.......... In cash, checks, store orders?...........
Law—Is it posted in workroom?..................................
Elevators—Number of?............ Are cables, gearings, etc., in apparently safe condition?.......... How is well-hole enclosed or covered?..

....

How is elevator entrance guarded?..............................

....

Are other guards required?...... How do doors open?..........
Is passenger elevator properly enclosed?........... Is child under 15 allowed to operate or care for elevator?........... Is minor under 18 permitted to do so?........ If so, state speed?.......
Hoistways—Number of?................ Are they enclosed or secured?....... Is apparatus in apparently safe condition?........
Machinery—Are males under 18 or women under 21 permitted to clean same while in motion?.............. Are children under 16 employed on dangerous machinery?........... Belt shifters in use? ...... Any machinery specially dangerous?...... Has its use been prohibited?............ Are belting, machinery, gearing, set screws, vats, pans, etc., safely guarded?.........................

....

Dust-creating Machinery—Any in operation?..................
How many emery or buffing wheels in use?....................
Number of persons continually employed on same?................
Males under 18 or females employed at polishing or buffing?........
Is proper exhaust fan provided and kept in operation?.............
Boilers—(Applicable to localities) where inspections are not provided by local laws or ordinances)—Number in use?...................
Were they inspected?.......... Date of inspection?........19...
By whom?...
Has duplicate certificate been filed?............................
Have they proper steam and water gauges and safety valves?.......
Accidents—Any since previous inspection?......................
Were they reported?...
Safety of Building—Are floors, walls, and all parts apparently safe?..
Walls, Ceilings—Do they need lime-washing or painting?.........
Stairways—Number of main stairways inside?.............. Outside?.......... Have they hand-rails?........ Properly screened? .... Are rubber coverings for stair steps necessary?........

Fire-escapes........... Balcony and inclined ladder? Balcony and straight ladder?.......... Straight ladder? .... Other means?...

Are exits unobstructed and accessible?...........................

Lighting—Are workrooms, halls, and stairs, leading to workrooms properly lighted?.......... Are such lights independent of motive power?..

Doors—Are they locked, bolted, or fastened during working hours? .... How do they open?......................

Water-closets—How many inside of building?.............. Outside?........ Is it practicable to maintain them on inside?........ Separate for sexes?.... Properly screened?.... Well ventilated and clean?........ Free from obscene writing or marking?.......

Wash-rooms—Are they suitable and convenient?.................

Dressing-room—Is one provided for females?.....................

Seats for Females—Are they maintained?............... Is use thereof permitted?...

Air Space—Is it ample during working hours?............ If not, state cubic feet of same in workroom...........................

Registers—All work done on premises?.........................

Is register of outside help kept?................................

Has copy of same been filed?....................................

Date of Previous Inspection—....................................

By.. Inspector

CHAPTER IV

BAKERIES AND BAKEHOUSES

The occupation of bread-making, baking and selling is undoubtedly one of the most important industries of urban life, and the sanitary conditions under which this industry is conducted are of the utmost importance to the health and well-being of the population. Unfortunately there is hardly an occupation which is so badly situated, so far as its sanitary aspects are concerned, as bread-making. The hygienic surroundings of bakeries, their unsanitary condition, the filthy state of most of the bakehouses in large cities, the uncleanly and unhealthy character of the workers in bakeries, and the unsavory and dirty condition of the bread and other bakery-products, have been noted and described over and over again.

The Causes. The following are the most potent causes of the unsanitary conditions of bakeries and their products, and of the ill health of the workers in the baking industry:

I. *Night-work.* The fact that city dwellers demand their daily bread in a fresh, almost hot, just-baked condition, compels the bakeries to do most of the baking during the night. Night-work is not conducive

to the health of employees, and is partly the cause of the anæmias, ill-health, the various skin eruptions, and the predisposition to tubercular diseases from which bakers suffer. Night-work also implies artificial lighting, which is conducive to neither cleanliness nor health.

II. *Location in Cellars.* Most occupations and trades find a home in houses and places specially built or adapted to their general and special needs. Hence the places where these industries are carried on are more or less specially adapted and fit for their several uses. This is not the case with most bakeries. While in large cities there are, and their number is happily on the increase, a number of large establishments constructed for manufacturing bread and bread-products on a large scale, most of the bread-making is carried on not only in ill-fitted and ill-adapted places, but not less than nine-tenths of the bakeries are situated in cellars of tenements and old houses. Any cellar at all is considered a fit and proper place for the establishment of bake shops, with very little or no reconstruction except that of building an oven.

The results of this anomalous condition are: (1) that the bakeries are located in very dark, damp, and foul-smelling habitations; (2) that they endanger the life of the inhabitants of the houses in which they are situated; (3) that they are extremely unhealthy for the workers who are compelled to spend a large part of their lives in these badly ventilated, badly lighted underground holes; (4) that the products of these underground manufactories are produced under unsanitary conditions, and are often in a filthy state, contaminated with sewage and infected by vermin; and (5) that that it is entirely

impossible to so control the trade of bread-making as to make it perfectly sanitary as long as the trade is carried on in cellars.

III. *Lack of Sanitary Supervision.* In spite of the many laws and the more or less progressive legislation on the subject of bakeries, found on most of the statute books in most States, there is still a lamentable lack of proper supervision and regulation of the industry, its sanitary control being divided for instance, in New York City, among three different departments, two municipal and one State; and even then, bakery supervision is only one of the many minor side affairs of these very busy departments.

If the above-named causes are the right ones and are productive of such dire results, it is evident that only by their removal can an amelioration and a practical reform of the baking industry be accomplished.

Remedies. It is almost impossible to abolish night-work in the bread-making industry. The evils of night-work cannot be abolished; they may only be mitigated, and, by the reform of the other conditions, the ill effect of night-work upon the workers greatly reduced.

The most radical and the most urgent of all reforms in the industry is an immediate or gradual, complete or partial, abolition of cellar bakeries.

No bakery or bake shop should be allowed to be conducted underground, or in any cellar of either private dwellings or tenement houses. All bakeries should be carried on in buildings or stores specially adapted or constructed for the purpose, and no one should be permitted to carry on the trade without a permit or license from a supervising sanitary department.

Only in this way will all the unsanitary features of bakeries, such as defective ventilation, dim lighting, bad plumbing, uncleanliness, danger of fires, and the many other evils of cellar bakeries, disappear. The last, but not least, reform is the proper codification of laws and regulations about bakeries, and the promulgation of a law creating a single municipal department, with a separate division on bakeries, responsible for the supervision of the industry.

Bakery Inspection. In bakery inspection attention should be paid to the following points: the place of work, the manner of work, and the character of the workers. In the inspection of the place of work the construction of the bakery should be noted, as well as the character of the floor, walls and ceilings, the protection against fire, the proper ventilation of the premises, the number, location and character of lights, the location and conditions of the plumbing pipes and fixtures, the temperature of the room, and the general maintenance of the premises. The inspection of the manner of the work should consist in the proper noting of the processes of bread- and cake-making; the noting of the adaptability and cleanliness of all the utensils, of the manner of storing and handling the flour, dough, and bread, and of the cleanliness of the whole process. The inspection of the employees themselves consists in the inquiry as to the number of employees, the presence and number of minors and children, the number of working hours, the general health of the workers, the provision of certain comforts, such as dressing- and wash-rooms for the workers, etc.

The following twenty-nine rules were suggested by

myself as minimum standards for bakeries, and as a basis for a new law in New York State.

(NOTE: These rules and other matter in re bakeries may be found in the author's report on "Bakeries and Bakers in New York State" published by the New York State Factory Commission.)

SUGGESTED MINIMUM STANDARDS FOR BAKERIES

(1) After a certain date no new bakeries shall be located in any cellar, nor shall any cellar, once vacated, be again occupied as a bakery.

(2) The owners of all existing bakeries shall be required to obtain a license from the State Labor Department. No bakery shall be conducted within the State without a proper license from the Labor Department.

(3) The Commissioner of Labor shall upon application of an owner of a bakery for a license, cause an inspection to be made of the premises, to determine the compliance with all the rules of the Department and of the Labor Law, and shall issue such license under additional certificate of the Local Department of Health or Health Officers, certifying that all sanitary conditions as to the manufacturing of food products have been complied with.

(4) Said license shall be good for one year after date of issue, and shall be renewed annually only upon an inspection, and shall be revocable for cause at any time.

(5) The hours of labor in all bakeries for all workers therein shall be limited to a maximum of ten hours in every twenty-four hours, and to sixty hours per week of seven days.

(6) No female worker under 21 and no minor under 18 shall be permitted to work more than eight hours per day, forty-eight hours per week, nor shall they be permitted to work between the hours of 7 P.M. and 6 A.M.

(7) Every employee in a bakery shall be required by the owner thereof to present a certificate from a reputable physician, said certificate to state that a physical examination has been made, and that he is free from any disease that would endanger the public health while working at his trade.

Work falling wholly or in part between the hours of 8 P.M. and 6 A.M. shall be considered night work, and shall be limited to eight hours in every twenty-four hours.

(8) No room can be used as a bakery or work room in a bakery in which artificial light is needed during the whole day. One window shall be required, said window to be at least 15 square feet in area.

(9) A window space in a bake or work room shall not be less than one-fifth of the floor space of such rooms.

(10) At least 450 cubic feet of area space and 50 square feet of floor space shall be allowed for every person employed therein.

(11) Every bakery shall be provided with ventilating fans, or in lieu of such fans, chimneys may be arranged so as to ventilate bakery properly.

(12) All windows shall be so arranged that they can be easily opened for the purpose of ventilation.

(13) In every bakery the space where the bake oven is located shall be partitioned off by a fire-proof partition dividing it from the rest of the work rooms.

(14) The walls and ceilings of all rooms in the bakery shall be plastered and cemented, and shall be painted in a light color or calsomined with lime, such surface to be cleaned as often as ordered by Commissioner of Labor.

(15) No wooden floors shall be permitted in any part of the bakery. All floors must be level and smooth and be made of non-absorbent material and be cleaned daily and kept clean at all times.

(16) All posts, columns, beams, etc., exposed within any part of the bakery shall be covered with sheet metal and painted over with light-colored paint.

(17) All windows and doors opening in any part of the bakery shall be screened with copper wire screens with meshes sufficiently close to prevent flies and other insects from entering through same.

(18) Every bakery shall be equipped with a sufficient supply of pure running water and shall be provided with at least one sink or wash-basin for every ten employees, and provision shall be made for a supply of hot water.

(19) No sink or wash-basin or any fixture within the bakery shall be enclosed with wood work, said sink or wash-basin to be kept in a sanitary condition at all times.

(20) Suitable dressing rooms, or places where workmen can change their clothes shall be provided in every bakery, and every employee in a bakery while at work shall be provided by the owners, free of cost, suitable caps, slippers, overalls or aprons, which shall be laundered at least twice a week, or oftener if necessary, free of cost to the employee.

(21) No chewing tobacco or spitting on floors in bakeries shall be

permitted, nor shall smoking be permitted to the employees while at work.

(22) No person shall be permitted to sleep in any part of a bakery, or in rooms where flour or meal used in connection therewith, or where any food products are handled or stored.

(23) Cuspidors of impervious material shall be provided, and cleansed daily.

(24) No water-closets or urinals shall be permitted in any bake shop or bake rooms. All such fixtures shall be placed in separate departments provided with a window to the outer air, and provided with artificial illumination wherever it is necessary.

(25) All utensils used in a bakery, and all places upon which the unfinished or finished materials are placed or stored shall be made of such material as may readily be cleaned and shall be kept clean at all times.

(26) All flour, starch, sugar and all other products used in the process of baking shall be stored either on platforms or shelves or shall be kept in covered metal barrels or receptacles so as to be clean and free from all dust and dirt.

(27) No domestic animals shall be permitted in any part of a bakery. All rooms of the bakery shall be free of insects, vermin, etc.

(28) All persons working in a bakery who handle or touch the products therein shall wash their hands and arms in clean water before beginning work, and every time they change from one kind of work to another.

(29) They shall have their finger nails cleaned, and shall be free from skin disease, or any infectious diseases.

CHAPTER V*

OFFENSIVE TRADES (NOISE, DUST, AND SMOKE)

THERE are a large number of occupations and trades which not only affect the health of the workers themselves, but frequently become a menace to the comfort and health of the neighborhood, thus coming under the legal definition of "public nuisances." Most of the occupations mentioned, however, under the term "offensive trades," are not always directly harmful to health or dangerous to life, and, except in the case of trades in which poisonous gases and fumes are allowed to escape within the premises, direct harm to the health is difficult to prove.

Most of the unpleasant effects of the trades are evidenced in the dust, noise, smoke, or bad odors produced by them. The number of trades which are offensive and may become public nuisances, on account of the noise, dust, smoke and smell they produce, is very large, and cannot be enumerated here; nor can a detailed description of each be given. A general statement, however, follows.

* Most of these chapters, as well as the previous chapter in Section II on "Occupations and Trades," have been reprinted (with kind permission of Messrs. Wm. Wood & Co.) from the author's article on "Hygiene of Occupation," in the last edition of the Reference Handbook of Medical Sciences.

Noise. The number of businesses which are characterized by excessive noise is large, especially in populous towns. Surface and elevated railroads, the driving of heavy wagons over rough pavements, machine shops, forge rooms, blacksmith shops, saw and planing mills, street venders, street music, etc., are a few of them. Excessive noises affect, especially, nervous, neurasthenic, and sick persons, causing irritability, sleeplessness, anorexia, and general disturbances of one sort and another. A New York physician gave to these symptoms the name of "Newyorkitis," but the malady, if there is such, would better be termed "urbanitis," as it is characteristic of all large cities.

The prevention of excessive noise is possible to a large degree by municipal action. Thus in New York it is not allowed to create unnecessary noises, especially at night, or near residential streets; street-band music is prohibited in the boroughs of Manhattan and the Bronx; railroad companies are compelled to remove "flat-wheel cars"; street peddling is not allowed at night, etc. With a wider introduction of asphalt pavement, a fruitful cause of noises will also be largely abolished.

Smoke. Among the many nuisances incident to city life is the black smoke belched forth from the chimneys of manufacturing establishments. The composition of the smoke as it leaves the chimney depends on the character of the fuel burned, as well as on the methods of combustion and the care with which these are carried on. Black smoke consists of carbon mechanically suspended, and also of other gases, such as carbonic acid, carbonic oxide, and hydrogen sulphide. Wood and bituminous

coal give off very abundant and black smoke, while hard coal gives off very little on account of its cohesiveness and complete combustion. When furnaces are of adequate capacity, with grates having a large area, with the coal spread in a thin continuous sheet, with the requisite amount of air, the production of smoke is greatly diminished. The other remedies, besides that of using anthracite coal, are the providing of tall chimneys, so that the smoke shall be emitted above the windows and dwelling houses; and the voluntary or compulsory introduction of smoke-consuming devices. There are a very large number of patented smoke consumers, most of them based on the principle of making a more thorough and complete combustion of all the particles of carbon in the fuel.

Dust. There are only a few businesses in which large quantities of dust escape outside of the establishments and become a public nuisance. These are carpet-cleaning and beating, the sandblasting of glass, and street sweeping. Carpet-cleaning, however, is now done in large establishments without producing dust. Proper methods have been devised for collecting the dust and preventing its escape. Nuisance from the sandblasting of glass may be avoided by keeping the industry out of residential streets, the dust usually falling not farther than about three hundred feet from the establishments. Street sweeping may also be done with comparatively little dust if the streets are first well sprinkled with water and if the cleaners are careful.

Smell. The trades and businesses which are or may become offensive on account of their smells are very numerous indeed, forming the great proportion of the

generally offensive trades. They are composed of all the numerous industries in which animal or vegetable matter is manufactured or stored, and which may at certain periods of the procedure give rise to offensive odors. We shall here, however, allude only to the following: (1) the keeping of live animals and of animal matter; (2) the killing of animals; (3) the manufacture and utilization of animal substances; (4) the manufacture of vegetable substances, etc.

CHAPTER VI

OFFENSIVE TRADES (THE KEEPING AND KILLING OF ANIMALS)

The Keeping of Live Animals. As in all offensive trades, the keeping of live animals becomes a nuisance only in populous towns. The nuisances created by the keeping of live animals, such as horses, cows, calves, swine, sheep, goats, birds, poultry, and rare and wild animals consist of: (1) the specific odors peculiar to each kind of animal; (2) the smell from the urine, excreta, and other organic matter; (3) the noises which the animals make, disturbing the neighborhood; (4) the flies and parasites which they attract to themselves; (5) possible infective materials and germs likely to be transmitted to men.

Most municipalities have laws which are intended to abate the nuisances created by the keeping of animals. The remedies for the nuisances are the following: (1) the total prohibition of the keeping of certain animals within city limits, or at least in over-crowded neighborhoods; (2) the restriction of the building of new places for animals; (3) proper veterinary supervision and disinfection, to prevent disease of animals and infection; (4) proper construction and maintenance of the places where they are kept; (5) the removal of all animal matter likely to give offensive odors, or to

become putrefied. The rules and regulations of municipalities embrace all of the above-enumerated prophylactic measures. Thus in New York no cows, horses, calves, swine, sheep, or goats may be kept in tenement houses; no stables are allowed on the same lot with a tenement house; and the keeping of all kinds of animals, even pigeons and chickens, requires a permit from the Health Department. In Boston stables are prohibited within two hundred feet of a church; in Chicago, in order to build a stable it is necessary to get the permission of the owners living within six hundred feet of the proposed stable.

Stable Nuisances. Most of the nuisance due to the keeping of live animals is given by horse stables, as comparatively few other animals are kept in cities.

Stables should be specially constructed. They should contain at least twelve hundred cubic feet of space and one hundred and twenty cubic feet of floor space for each horse; stalls should be at least six feet wide and nine feet long, and the stable should be well ventilated. The floors of stables should be of some impervious material, such as concrete, cement, or brick set in cement; no woodwork that cannot be easily taken off should be laid on flooring. There should be provision for an unlimited supply of water, the floor should be properly graded and drained, the stalls provided with longitudinal "valley drains," with adjustable covers easily taken up, and the drains should all be tightly connected with the sewer by a properly trapped, extra heavy pipe. No accumulations of manure should be allowed. As soon as the manure is collected, it should be put into barrels or pressed into bales, and removed daily. It should

be removed within the stable, and the carts containing it should be well covered before they start out. The removal hour should be at night or early in the morning. Thus in Boston manure may be removed only after 12 (midnight); in Jersey City between 6 P.M. and 7 A.M. The stables should be kept scrupulously clean and should be frequently disinfected with a solution of one pint of formalin to three gallons of water or with a similar solution of carbolic acid; corrosive sublimate solution and creolin may also be used. There is no reason why, with such precautions, the keeping of horses should be attended by nuisance. The keeping of other animals may be made inoffensive by means of similar methods.

The Keeping of Animal Matter. The storage or keeping of animal matter, of manure, offal, bones, hides, horns, skins, fish, garbage, etc., may be very offensive, on account of the tendency of these substances to speedy putrefaction and decomposition, when they emit sickening odors, unbearable by many, causing headache, loss of appetite, and nausea. The prevention of nuisance from the decay of these substances may be had by the following means: by their immediate destruction, by the burning of all needless matter likely to decompose; the immediate removal of such matter from habitations; by scrupulous cleanliness; disinfection; and the keeping of matter in tightly closed vessels.

The Killing of Animals. The killing of animals is one of the oldest industries of mankind, and has always been in need of State supervision and control, from the time of Moses in ancient Egypt until now. The nuisance created by slaughtering animals lies chiefly

in the odor peculiar to the slaughter-houses, although other things, such as the noise created by the animals, the flies and parasites attracted by the animal matter, also the possibility of infection by animal diseases, all play their part in the creation of this nuisance. The offensive smell is due to the animals themselves, to the fresh animal guts, blood, and other products, and to the decomposing animal matter within the buildings. The remedies for the nuisance are: the prohibition of slaughtering in any but specified localities; the construction of special municipal abattoirs; the proper building and maintenance of the slaughter-houses, their supervision and inspection; the immediate removal of all by- and waste-products; the refrigeration of meat; the absolutely clean condition of the places; the provision of special means for destroying foul- and ill-smelling matter, and the disinfection of the premises.

Municipal provisions regarding slaughter-houses were inaugurated in the United States as early as 1692 (in Boston), and are now found in nearly every community. In New York City, slaughter-houses are located only in specified localities, of which there are but four or five. In Boston the slaughtering of animals is concentrated in the Brighton abattoir, and in New Orleans, in the municipal abattoir. Cleanliness in the slaughter-houses is provided for in the various sanitary codes, as in the following section of the New York law:

"All those who are responsible for the places should cause such places and their yard and appurtenances to be thoroughly cleansed and purified, and all offal, blood, fat, garbage, refuse, and unwholesome or offensive

matter to be removed at least once in every 24 hours after the use thereof; and they shall also at all times keep all woodwork, save floors and counters, thoroughly painted or whitewashed." An unlimited supply of water is even more needed in abattoirs than in stables. The slaughtering of poultry and smaller animals should also be controlled by the municipality, and most of the prophylactic measures used in slaughter-houses of larger animals are applicable to them also.

CHAPTER VII

OTHER OFFENSIVE TRADES

Utilization and Manufacture of Animal Substances. Modern industry does not allow anything to go to waste, and in animal trades there is hardly a substance which is not utilized in some way. Among the many branches of these utilization industries to be discussed here are the following: the rendering of fat and lard; bone and blood-boiling; gut-cleaning; the manufacture of glycerin, soap, and glue, and the preparing and tanning of skins and hides.

Fat Rendering, Lard Refining. Most of the rendering of fat is done by the action of heat, although there are several chemical methods in vogue. Since the trade became concentrated in large establishments, the old method of rendering fat in open kettles has become happily obsolete. The chief nuisance of fat-rendering consists in the odors "which are all caused, partly by the storage of decomposing fat on the premises, but mainly by the distillation of portions of the fat, which produces certain ill-smelling substances, such as acrolein and allylic alcohol, with sometimes capric, caprylic, and caproic acids."

The prevention of nuisance from fat-rendering is accomplished by the following measures: (1) the use

of undecomposed animal matter; (2) the employment of a low temperature in rendering; (3) the boiling of fat in tightly closed vessels; (4) the use of condensers for the removal and destruction of the gases and odors. The New York Sanitary Code has the following section: "That no fat, tallow, or lard shall be melted or rendered except when fresh from the slaughtered animal, and taken directly from the place of slaughter, and in a condition free from sourness and taint, and all other causes of offence at the time of rendering; and that all melting and rendering are to be in steam-tight vessels; the gases and odors therefrom to be destroyed by combustion or other means equally effective." Himes says: "The great secret in preventing nuisance is the avoidance of burning the materials, or even raising them to high temperature. The lower the temperature at which the work can be successfully carried on, the less is the risk of producing offensive smells. The temperature need not exceed 120° F." When steam methods of rendering are used, the need of condensers is imperative. "Condensers may be of several styles and shapes. The water may be introduced at the top, and broken by means of a plate, a short distance below, the shower may also be made by means of a rosette. The condenser itself may be made of iron, copper, or even wood. It should be made as high as possible, in proportion to the diameter. The gas should be introduced at the bottom, and passing up through the water shower, connect with the furnace fires by a pipe near the top." (Goldsmith.) Among the chemical methods of fat-rendering is D'Arcet's, which is by the separation of the fat from its membranes

by the action of sulphuric acid. Lard refining differs little from the general rendering of other fats, and, being done mostly by the low temperature method, it is not offensive.

Bone and Blood Boiling. In the processes of boiling these animal substances, odors may arise which may be quite offensive. The following preventive measures are recommended by the Philadelphia Board of Health: "The floors of all bone-boiling establishments and depositories of dead animals shall be paved with asphalt or with brick or stone, well laid in cement, and shall be well drained. The boiling of bones, etc., shall be conducted in steam-tight kettles, boilers, or cauldrons, from which the foul vapors shall first be conducted through scrubbers or condensers, and then into the back part of the ashpit of the furnace fire, to be consumed. When bones are being dried after boiling, they shall be placed in closed chambers, through which shall be passed, by means of pipes, large volumes of fresh air, the outlet pipe terminating in the fire-pit."

Gut-cleaning. The utilization of the small intestines of animals for sausage skins and the manufacture of catgut is necessarily accompanied by a great deal of stench from the foul-smelling contents of the guts and the decomposition of animal matter. "The processes should be carried on away from habitations; the guts, etc., should not be allowed to come in a foul state, but must be utilized immediately, and proper precautions taken to let no foul matter cling to the floor or surfaces of the establishment. This may be accomplished by the use of plenty of water. The water in the tank where the intestines are macerated may be disin-

fected by a weak solution of chloralum or chlorinated soda."

The Manufacture of Soap. Soap is manufactured from fat and alkalis. It may become a nuisance: (1) on account of the large quantity of fat, tallow, and fat animal residue which are collected from all waste animal matter, and which, by the time they reach the soap factory, are in a decomposing state; (2) through the processes involved in fat rendering; (3) through the odors arising from the huge vats and tanks where the fat is boiled with the alkaline lye. The prevention of nuisance from the first cause is accomplished by insisting that only fat in a fresh state shall be allowed in the soap factories. The means of preventing nuisance from fat-melting and rendering have been described. The nuisance caused by the odors arising from the boiling tanks can be prevented by fitting these with covers and conducting the vapors either outside through a tall chimney, or, as in fat-rendering, through proper condensers.

Glycerin. When the fatty acids of the fats in soap manufacture combine with the alkalis, the base left is a residue in the form of glycerin, which, before being fitted for the market, must be refined several times. During this process sweetish, unpleasant odors are given off, which can be prevented by the same means as those which are used in treating odors from fat rendering.

Glue-making. All kinds of animal waste matter, hoof, horns, skin scraps, leather scraps, etc., are used for the extraction of glue. As in the other processes employed for the utilization of all animal waste matter,

the nuisance comes from the decomposing material, from the odors given out during boiling, etc., and from the offensive residue or "scrutch." The remedies are the same as in other kindred processes.

Treating and Tanning of Skins and Hides. Animal skins, before they are converted into lasting leather, must go through a number of complicated processes. In the scraping, salting, hairing, brining, liming, puering, tanning, curing, and other processes very offensive and disgusting odors often arise; and in liming some sulphureted hydrogen may also be evolved. The process named "puering" consists in soaking the hides in a liquid composed of dog's dung. Tanning establishments should not be allowed in residential localities. The various processes may be carried on with little offense if the places are properly constructed and well kept.

Manufacture of Other Substances. Other substances and manufacturing processes which may become offensive, are the following: illuminating-gas, petroleum refining, distilling, brewing, vinegar-making, sugar-refining, the boiling of oil, the manufacture of varnish, cooking, etc.

Illuminating-gas. The nuisance caused by the presence of gas-works in populous localities is due to various gases and odors given off during the many stages in the process of distilling gas from bituminous coal. The especially objectionable process is the "liming," or the passing of the gas through a closed chamber filled with quicklime, which is afterwards deoxidized, giving off ammonium sulphide and sulphureted hydrogen. Oxide of iron has been substituted

for quicklime, with a material lessening of offensiveness. Notwithstanding all the care employed and despite the modern invention of condensers, scrubbers, and other means for destroying and absorbing offensive gases during the manufacture of illuminating-gas, this business is still quite a nuisance. The best remedy is to remove it as far as possible from habitations.

In the processes of refining petroleum, offensive odors are given off. These are due to the escape of fumes during its distillation, as well as during the agitation of the refuse or "sludge" acid with alkaline solutions. Goldsmith recommends that the wash water from the agitators be passed through a series of troughs furnished with cross slots, to retain all oily or tarry matter; and that the treatment of the sludge be carried on at a distance from crowded neighborhoods.

The nuisances caused by the processes of brewing, distilling, sugar-refining, and the other industries mentioned, consist in the odors given off at certain stages of manufacture, and may be prevented by the same methods as those described in the section on "Fat Rendering."

Tracy gives rules for controlling the nuisance caused by the odors and vapors given off during the manufacture of the various substances, as follows: (1) the substances should be conveyed and stored in tight vessels; (2) less offensive processes should be substituted for the offensive processes employed; (3) the proper construction of the places in which nuisances arise, should be provided for; (4) plenty of water should be used to insure proper cleanliness and drainage; (5) all offensive odors should be destroyed by passage

through condensers, etc., and thence, into fire-pits where they will be properly consumed.

Gases and Vapors. The number of the trades which may become a nuisance to the community on account of the vapors, acid fumes, and gases which are evolved in their processes, and are allowed to escape into the surrounding air, is very large. Among the more important of these are all the chemical trades, the manufacture of alkalies, ammonia, bleaching-powder, soda, and glass, assaying, smelting, and the manufacture of jewelry, lead paint, certain drugs, etc.

The nuisance created by all of these trades can be summed up in the following: (1) Odors offensive to the neighborhood. (2) Deleterious gases. (3) Destruction of vegetation in the neighborhood.

The remedies advised for the prevention, or at least mitigation, of the nuisances are: (1) Removal, whenever possible, from crowded localities. (2) Dilution of the gases and vapors by air. (3) Condensation of gases by cooling them with water, by passing them once, or several times, either through condensers filled with water or through scrubbers filled with wet coke. (4) Absorption through discharging all gases into fire pits, where they are destroyed by the action of fire or by passing them through neutralizing substances, which are of course different for each of the different gases.

SECTION III—FOODS

CHAPTER I

FOODS AND FOOD SUPPLY

"*Food is that which, when taken into the body, builds tissue, or yields energy.*" Everything is, therefore, food which may be used for the purpose of replacing the loss due to the wear and tear of the cells of the body, or of supplying heat and energy to the body, or of storing up such energy for future use.

The *sources* of human food are the vegetable, mineral, and animal kingdoms. Certain minerals and a large number of cereals, roots, vegetables, fruits, and nuts are used, either in their natural state or specially prepared and somewhat modified by art and science. The flesh of a large number of animals is used as human food, when specially prepared and modified by man.

All food contains, beside nutrients and waste matter, also a greater or smaller percentage of water.

Chemical Composition. In their final analysis all foods contain the elements: carbon, hydrogen, oxygen, nitrogen, sulphur, sodium, potassium, calcium, magnesium, etc. Most of the foods taken into the body,

however, are derived from the organic world; the only foods taken from the inorganic world are mineral matter and water.

The first subdivision of food is therefore into *organic* and *inorganic*.

The mineral substances used for food are sodium, potassium, magnesium, chlorine, sulphur, phosphorous, iron, silica, fluorine, iodine, etc.

The water and mineral substances used for food are taken either in their natural state or in combination with organic foodstuffs.

Organic foods are divided into two main groups; nitrogenous and non-nitrogenous.

Nitrogenous	Protein	White of eggs, curd or casein of milk; lean meat, gluten of wheat, etc.

Non-nitrogenous	Carbohydrates: Sugar, starch, etc.
	Fats: Animal, vegetable.

The Relative Use and Value of Each Food Component. Each of the food components is essential to life. A certain amount therefore of each must be used in order to sustain and continue life.

Water. Two-thirds of the weight of the human body consists of water. The body loses water constantly through the lungs, skin, and excretory ducts. The amount of the daily loss of water depends upon many factors, and is estimated at from 2000 to 3000 grams. There is needed, therefore, a considerable amount of water for daily use. This is partly furnished by the water which is a component of nearly every food,

and partly by the water consumed with or in addition to the food.

Mineral Matter. The body contains a quantity of mineral matter which is found in the form of ashes when the body is burned. The minerals which have been enumerated are found in the body and are also needed as food for the formation of bone and as an aid to digestive processes. It is claimed that the lack of certain inorganic matters, especially acids, is capable of producing the disease called "scurvy" which is found among sailors and others who are deprived of foods containing those acids.

Protein. The muscles, the blood, the lymph, and other parts of the human body and organs contain a large percentage of protein or albuminous matter. There is a constant loss of these protein cells in the metabolism of the body, and consequently a need to repair and replace this loss. This is accomplished by the ingestion of foods which have a certain percentage of protein in their composition. All animal foods contain a large proportion of proteins, while vegetables with a few exceptions contain but a small proportion of protein.

The chemical composition of protein matter depends upon its source, thus there are different varieties of protein matter such as the albumins, globulins, albuminoids, nucleo-albumins, peptones, etc.

Carbohydrates and Fats. The heat and energy of the body use up certain elements such as oxygen, carbon, and hydrogen, and these must be replaced by food. The carbohydrates and fats supply this need. Fats and carbohydrates are to some extent inter-

changeable. The principal elements of food which furnish the carbohydrates are the sugars and the starches which are converted by the digestive processes into sugars. The fats are found in foods in the form of fat and oil. There is considerable fat in animal food but only a relatively small percentage of carbohydrates. Many vegetables contain starches and sugars in large quantities.

Estimates of Food Values. The use of food produces energy and heat. This heat may be measured, and serves as criterion of the heat and food values. The measure of heat is in "Calories." A calorie is the amount of heat required to raise 1 kilogram of water, 1° Centigrade. It has been found out that:

1 gram of protein gives	4.1	available calories
1 gram of carbohydrates	4.1	"
1 gram of fat	9.3	"

By the aid of this table it is possible to calculate the fuel value in calories per certain weight of food, f. i. 100 gram.

For instance the composition of milk is protein, 3 per cent; sugar, 5 per cent; and fat, 4 per cent. The number of calories represented by 100 grams of milk will be as follows:

Protein, $3 \times 4.1 = 12.3$; fat, $4 \times 9.3 = 37.2$; carbohydrates, $5 \times 4.1 = 20.5$. Total $= 70$ calories.

DIETARY STANDARDS FOR MAN IN FULL VIGOR AT MODERATE MUSCULAR WORK (LANGWORTHY)

Condition.	Protein. Gram.	Energy. Calories.
Food as purchased............	115	3.800
Food as eaten................	100	3.500
Food as digested..............	95	3.200

The following table of the composition of various food materials and their fuel value in calories per pound is taken from the charts prepared by C. F. Langworthy, Food Expert of the U. S. Department of Agriculture:

Food.	Water. Per Cent.	Protein Per Cent.	Fat. Per Cent.	Carbo-hydrates Per Cent.	Ash. Per Cent.	Food Values in Calories per Pound.
Whole milk	87.0	3.3	4.0	5.0	0.7	310
Skim milk	90.5	3.4	0.3	5.1	0.7	165
Butter milk	91.0	3.0	0.5	4.8	0.7	160
Cream	74.0	2.5	18.5	4.5	0.5	865
Whole egg	73.7	14.8	10.5	....	1.0	700
Egg white	86.2	13.0	0.2	....	0.6	265
Egg yolk	49.5	16.1	33.3	....	1.1	1608
Cream cheese	34.2	25.9	33.7	2.4	3.8	1950
Cottage cheese	72.0	20.9	1.0	4.3	1.8	510
Lamb chop	53.1	17.6	28.3	....	1.0	1540
Pork chop	52.0	16.9	30.1	....	1.0	1580
Smoked ham	40.3	16.1	38.8	....	4.8	1940
Beef steak	61.9	18.6	18.5	....	1.0	1130
Dried beef	54.3	30.0	6.6	....	9.1	840
Cod	82.6	15.8	4.0	....	1.2	325
Salt cod	53 5	21.5	3.0	....	24.7	410
Smoked herring	34.6	36.4	15.8	....	13.2	1355
Oyster	86.9	6.2	1.2	3.7	2.0	235
Mackerel	73.4	18.3	7.1	....	1.2	645
Olive oil	....	....	100.0	....	....	4080
Bacon	18.8	9.4	67.4	....	4.4	3030
Beef suet	13.2	4.7	81.8	....	0.3	3510
Butter	11.0	1.0	85.0	....	3.0	3410
Lard	....	....	100.0	....	....	4080
Corn	10.8	10.0	4.3	73.4	1.5	1800
Wheat	10.6	12.2	1.7	73.7	1.8	1750
Buckwheat	12.6	10.0	2.2	73.2	2.0	1600
Oat	11.0	11.8	5.0	69.2	30.0	1720
Rye	10.5	12.2	1.5	73.9	1.9	1750
Rice	12.0	8.0	2.0	77.0	1.0	1720
White bread	35.3	9.2	1.3	53.1	1.1	1215
Whole wheat bread	38.4	9.7	0.9	49.7	1.3	1140

Food.	Water. Per Cent.	Protein Per Cent.	Fat. Per Cent.	Carbo-hydrates Per Cent.	Ash. Per Cent.	Food Values in Calories per Pound.
Oat breakfast food....	84.5	2.8	0.5	11.5	0.7	285
Toasted bread.......	24.0	11.5	1.6	61.2	1.7	1420
Corn bread..........	38.9	7.9	4.7	46.3	2.2	1205
Macaroni...........	78.4	3.0	1.5	15.8	1.3	415
Sugar...............	....	....	....	100.0	....	1860
Molasses............	25.1	2.4	....	69.3	3.2	1290
Stick candy.........	3.0	....	....	96.5	0.5	1785
Maple sugar.........	16.3	....	....	82.8	0.9	1540
Honey..............	18.2	0.4	....	81.2	0.2	1520
Parsnip.............	83.0	1.6	0.5	13.5	1.4	230
Onion..............	87.6	1.6	0.3	9.9	0.6	225
Potato..............	78.3	2.2	0.1	18.4	1.0	385
Celery..............	94.5	1.1	....	3.4	1.0	85
Shelled bean, fresh....	58.9	9.4	0.6	29.1	2.0	740
Navy bean, dry......	12.6	22.5	1.8	59.6	3.5	1600
String bean, green....	89.2	2.3	0.3	7.4	0.3	195
Corn, green.........	75.4	3.1	1.1	19.7	0.7	500
Apple..............	84.6	0.4	0.5	14.2	0.3	290
Dried fig............	18.8	4.3	0.3	74.2	2.4	1475
Strawberry..........	90.4	1.0	0.6	7.4	0.6	180
Banana.............	75.3	1.3	0.6	22.0	0.8	460
Grapes.............	77.4	1.3	1.6	19.2	0.5	450
Raisins.............	14.6	2.6	3.3	76.1	3.4	1605
Grape juice.........	92.2	0.2	....	7.4	0.2	115
Canned fruit........	77.2	1.1	0.1	21.1	0.5	415
Fruit jelly...........	21.0	....	....	78.3	0.7	1455
Walnut.............	2.5	16.6	63.4	16.1	1.4	3285
Chestnut............	5.9	10.7	7.0	74.2	2.2	1875
Peanut.............	9.2	25.8	38.6	22.4	2.0	2500
Peanut butter.......	2.1	29.3	46.5	17.1	5.0	2825
Cocoanut...........	3.5	6.3	57.4	31.5	1.3	3125

Preparation of Food and Diet. By diet is understood the quantity, quality, and kind of food taken in by the person daily.

There are a great many factors determining the value of the average person's diet. The main factors are as follows:

The person: Age, weight, physical condition, race, condition of rest.

The food: Chemical composition, physical conditions as to form, volume, consistency, percentage of edible and inedible parts, temperature, etc.

General conditions: Climate, temperature.

It is difficult to make hard and fast rules for dietetic standards. Human beings easily adjust themselves to different kinds and forms of food, and during health, as a rule, do not suffer much, except when they take either too much or too little food, are fed exclusively on one food or on food which lacks some of the necessary nutrient ingredients.

A prolonged and constant over-use or under-use of certain principles of food is bound to produce pathological conditions and is the cause of certain diseases of digestion and metabolism.

The form and consistency of food is of much importance, for food must be in such condition as to be readily digested. Many foods must be mechanically ground by the teeth, some are chemically acted upon in the mouth by the processes of mastication. This not only prepares the food for the stomach by softening and dividing it into small particles, but also aids much in the conversion of the starches of vegetables and cereals into sugars.

There is still much controversy as to the value of an exclusively vegetarian diet, as well as to the comparative percentage of the protein and carbohydrate elements needed for persons. For the average healthy person a mixed diet of animal and vegetable food is probably the most appropriate, and the amount of

the protein matter must be somewhat limited, much depending upon the physical condition and habits of the person.

The cost of food depends also upon very many factors. Often it is not the most costly food that is the most nourishing, as some of the common causes of the high cost of food are its rarity, the difficulty of obtaining it, the manner of preparation, the place where it is sold, and the matter of taste. For physical subsistence cereals, vegetables, nuts, fish and flesh of animals furnish all the necessary nutrient qualities, and some among these are of comparatively low cost, the nutritive value of which, however, is quite as great if not greater, than that of the more costly foods.

Raw, Cooked, and Prepared Foods. Some cereals, a large number of vegetables, most of the fruits, a number of nuts, and some forms of animal foods may be taken in their natural state. The flesh of animals is very seldom used raw, although the fat is very often so used, and in some climates the flesh also is eaten raw.

The process of cooking foods greatly improves the consistency and form of most foods, develops the flavors, increases the digestibility, improves the taste, and generally enhances the value of food for human beings. Much of the increased digestibility and value of the food depends upon the various forms or processes of cooking.

The food may be heated (pasteurized 160° F. for 10 minutes). This process destroys certain pathogenic germs, softens the food, and is valuable for the preparation of milk, for the cooking of eggs, etc.

Boiling, stewing, steaming, baking, roasting, and fry-

ing are some of the various modes of subjecting foods to heat. The value of each process depends more or less upon the kind of food and various other conditions.

In *stewing*, the food is cut into small pieces and put in cold water and heated slowly. This is an economic method of preparing certain meats and vegetables.

Boiling is a more rapid process in which the food is put into hot water and kept at 212° F. and above.

Certain foods, especially fruits and cereals, are more tender and digestible when prepared by means of *steaming*. The food is placed in a double pot, the water is boiled in the lower part, and the food in the upper part is subjected to the steam formed by the heat.

Baking and *roasting* are processes by which the food is exposed to the direct radiation of heat in open or enclosed stoves.

Frying is a form of roasting in which the food is placed in a pan and fried in fat.

Boiling and frying somewhat toughen the fibres of the food and render it less digestible than the other processes.

Care, Storage, and Preservation of Food. All foods when left exposed for some time undergo a process of deterioration and decomposition. This is due to the breaking up of organic tissue into its simple components, and finally into its primary elements, the decomposition being due to the action of micro-organisms. The majority of the micro-organisms which cause the breaking up of the tissue of the foodstuffs are harmless. The deterioration of food is also due to various molds, yeasts, and other vegetable and animal germs which are found almost everywhere.

In order to prevent the deterioration of foodstuffs, the action of the destroying germs must be inhibited or stopped.

Foods that are over-ripe or underripe, that have fungi, parasites, or worms in them, or that lack protective coverings usually undergo more rapid decomposition. Certain foods, when in a process of decomposition develop chemical poisons which cause serious disturbances in those eating the foods. This is sometimes called ptomaine poisoning.

In order to care, store, and preserve foods in the house, certain conditions are necessary: (1) a sound condition of the food; (2) dry air: moisture is absolutely necessary to decomposition, and its presence favors the growth and development of low organic and bacterial life; absence of moisture is a preventive of decomposition; (3) absence of flies and insects: certain insects injure the food and also bring to it germs which aid in decomposition; all foods must be examined and covered to prevent the access of these insects. It is best to have all foods covered or wrapped in protective coverings so as to prevent their injury from outside agents.

Temperature. A low temperature, even below the freezing point, does not kill bacteria, but it stops and inhibits their further growth. At a temperature of 40 to 45° F., the growth of germs is greatly retarded and this is the best temperature at which to keep and store foods.

Food in the house is stored in separate rooms, pantries, cellars or ice chests. Wherever it is stored care must be taken to have an equable temperature, below

45 degrees, and as far as possible each food should be kept apart from other foods.

Drying. The method of drying foods in order to preserve them is efficient in proportion to the thoroughness of the process. Drying is adaptable to meats, cereals, seeds, and some fruits. The drying is done either in the sun or on fires. Some foodstuffs when reduced to a dry powder may be preserved for a long time.

Salting and Pickling. Salting and pickling are partly chemical and partly physical methods of food preservation. Salt prevents decomposition by reason of its antiseptic qualities and by its absorption of moisture. This method is applicable to meats and fish. Fish are also preserved in brine or salt solution. Pickling is the keeping of food, such as fish, certain vegetables and fruits, in vinegar. These processes harden to some extent the fibres and diminish the digestive qualities of the food.

Smoking. The method of food preservation by smoking is really a combination of several methods, dry, salt, and chemical. It is said that the creosote in wood smoke to which the food is exposed serves as an antiseptic. Certain meats and fish are preserved by smoking. This hardens the fibres and makes them less digestible.

High Temperature. Foods may be preserved by subjecting them to high temperature. This destroys all micro-organisms and prevents the decomposition of the food. The heating of the food to 140° F., from 10 to 15 minutes is called *pasteurization*. Heating to the boiling-point and subjecting the food to this heat

for one-half hour or longer is called *sterilization*. It effectively destroys all micro-organisms, even the spore-bearing bacteria.

Canning. Many foods may be preserved for indefinite periods of time by sterilization with heat and by subsequent storage in hermetically-closed tin or glass receptacles. Many kinds of meats, fish, fruits, and vegetables are at present preserved by the process of canning. The food is cut in appropriate forms and placed in tin cans of various sizes. It is then covered with hot water and boiled. The cans are covered except for a very small opening at the top, and subjected to a high degree of heat in steam boilers for the period of an hour or more. The opening is then sealed with solder, and after the cans have again been subjected to heat, they are taken out, cooled, labeled, and stored. In this condition they may be kept for very long periods.

If the food in the cans is not properly sterilized and if decomposition subsequently sets in, the carbonic acid gas develops in the cans and causes a bulging out of the top or bottom of the can which thus indicates that the food has undergone some decomposition. The food in such cans should be rejected.

Adulteration. By adulteration is meant the "altering" of the normal composition and constituency of the food. Food adulteration is accomplished in various ways: (1) by mixing with the food some foreign substance in order to reduce, lower, or injure its quality and strength; (2) by the entire or partial substitution of an inferior substance; (3) by the entire extraction of a portion of valuable substance from it; (4) by the sale

of imitations leading the consumer to purchase articles he never intended to buy; (5) by the sale of food in part or wholly of a diseased, decayed, or decomposed substance; (6) by coloring, coating, polishing, or powdering the food, thus concealing its poor quality, or making it look better than it is; (7) by introducing into the food a poisonous constituent, or any ingredient likely to be harmful to the consumer.

Adulteration may be harmful, fraudulent, or accidental. Adulteration is made harmful by the addition of injurious substances, by the decomposed or unwholesome state of a part or the whole of the food, or by the dilution or extraction of some nutrient part of the food, thus rendering it less nutritious. Under fraudulent adulterations are classed all those which do not directly or indirectly harm the consumer, except in deceiving him and making him pay more than he would normally have paid.

There is much adulteration of foods in commerce and trade. The Federal Food and Drug Act makes stringent provisions against adulteration and misbranding and much has been done by the Government to insure the purity of foods and the honesty of their adulteration. Much more, however, remains to be done. The methods of adulterating foods are many and change from time to time.

Cereals, Nuts, Fruits, Vegetables. Vegetable foods are classified by Harrington as follows:

1. Farinaceous seeds: (*a*) Cereals: wheat, rye, barley, oats, corn, buckwheat, rice. (*b*) Legumes: peas, beans, lentils.

2. Farinaceous preparations: Sago, tapioca, arrowroot.

3. Fatty seeds: Nuts, almonds, cocoanuts, walnuts, peanuts, chestnuts, etc.

4. Vegetable fats: Olive oil, cotton-seed oil.

5. Tubers and roots: Potato, artichokes, carrots, turnips, parsnip, beet, etc.

6. Herbaceous articles: Asparagus, cabbage, cauliflower, sprouts, lettuce, spinach, beet tops, dandelions, leeks, onions.

7. Fruit products used as vegetables: Tomato, cucumber, squash, pumpkin, egg-plant, vegetable marrow.

8. Fruits: Apples, pears, peaches, apricots, plums, cherries, oranges, etc., berries, bananas, figs, lemons, etc.

9. Fungi: Edible mushrooms, truffles.

10. Saccharine preparations: Cane sugar, maple sugar, honey, molasses, etc.

This classification includes most of the vegetable foods. The chemical compositions and calorie values of some of these have been given in the table on pages 191, 192.

Cereals. Cereals contain a large percentage of starch, a considerable percentage of protein, some mineral matter, and extractives. Some of the cereals like rice contain more starch, while others like oats, contain less starch. The cereals are an indispensable part of human diet. While most of the cereals may be eaten raw, dried, or specially prepared in the seed, they are commonly used in the form of ground flour mixed with water and baked. The proper making of edible bread is a domestic art long monopolized by women, although at present in the cities this domestic art threat-

ens to be lost, for most of the bread is baked in special bakeries.

Legumes. The legumes are valuable foods. They contain not only a large proportion of starch, but also a high percentage (22 to 25 per cent) of proteids, and are said to be good substitutes for meat foods.

Farinaceous Preparations. Most of the farinaceous preparations contain a large percentage of starch.

Nuts. Nuts are valuable on account of their large contents of protein and large percentage of oil.

Vegetable Oils. The vegetable oils are valuable foods and are used as substitutes for animal fats.

Tubers. Among the tubers, potatoes deserve their reputation as a valuable food and furnish much of starch which the human organism needs.

Roots. Roots contain a considerable part of sugar, and with herbaceous articles serve as food adjuncts to be used with other foods.

Fruits. Fruits contain a large percentage of water, sugars, acids, and very little protein matter.

Saccharine Preparations. The use of saccharine preparations is very general. They possess valuable food properties in that they furnish heat energy, but they are used more for the agreeable taste. They are likely to be used in too great quantities, thus causing over-supply of this principle of food and digestive fermentation.

Beverages. A certain amount of water is a part of almost all foods, some is taken in its pure form, and large quantities are consumed in the form of various beverages, like tea, coffee, beer, cider, soda, etc. Some of these contain a greater or smaller quantity

of sugar and acids, others contain certain alkaloids, which have found favor, and others contain a certain percentage of alcohol. Whether such beverages are needed is a disputed question. Some advocate their use, others deny that they possess any beneficial properties. The overuse of most of them, especially those containing a large percentage of alcohol, undoubtedly endangers the health.

Condiments. This term designates certain articles which are used, not for their food value of which they have none or very little, but for the flavor they impart to food and the stimulation they give to the appetite and digestion. Among the principal condiments are vinegar, salt, spices, pepper, mustard, etc.

CHAPTER II

MEAT AND THE MEAT SUPPLY

The Hygiene of Meat Foods. The hygiene of meat foods may be considered according to the following subdivisions:

Dangers to Health. Infection by entozoa, infection by bacteria, toxins, and ptomains.

Etiology. Diseases of animals, conditions of the animals, postmortem changes, postmortem infection, adulteration.

Prophylaxis. Hygiene of the food animals: meat inspection, antemortem and postmortem; the hygiene of places and persons; preservation, sanitary supervision of manufacture, etc.

Parasitic Diseases Due to Meat. These are due to (1) infection by tapeworms, (2) infection by trichina, and (3) infection by echinococci.

Tapeworm. The two principal species of tapeworm found in man which are due to meat infection are the Tenia saginata and the Tenia solium; the former is due to infection by "measly" beef, the latter by "measly" pork.

The "Cysticercus cellulosæ" is the larval form of the Tenia solium. It appears in hogs in the shape of minute bladder worms, encased in little cysts which are found in the intestines, muscular fibres, brain,

liver, and other parts, and especially under the tongue, where it may readily be recognized. The cysticercus is derived from the segment and egg of the Tenia solium, which are passed from the human intestine, ingested by the hog, and on reingestion by man develop again into tenia.

The Cysticercus bovis is the larval form of the Tenia saginata of man, and is found in the intermuscular fibres and connective tissue of cattle.

Trichina. The *Trichina spiralis* is a parasite found mostly in the muscular fibres of pork, in the form of minute spiral-form worms, which are encapsulated, but may be recognized with the naked eye as white specks. The ingestion of pork infected by trichina causes in man the acute disease called "*trichinosis*," which is due to the presence of the trichina in the muscular fibres. Its symptoms resemble those of typhoid fever. The disease is often fatal.

Echinococcus. Echinococcus sometimes infects sheep, and, rarely, cattle. The infected meat causes in man the hydatid diseases. The infection comes in the first place from the Tenia echinococcus found in dogs.

Meat Infection by Bacteria. Pathogenic bacteria may be found in the flesh of animals, which, so infected, is capable on consumption of producing disease. The pathogenic bacteria may originate in the diseased condition of the live animals suffering from the infectious diseases, or they may gain entrance into the meat of healthy animals through infection by contact, etc., after killing.

The diseases of animals infectious to man which are caused by pathogenic bacteria and which, it is claimed,

may be transmitted through their meat to man, are the following: tuberculosis, pleuro-pneumonia, foot and mouth disease, cattle plague, anthrax, glanders, malignant edema, erysipelas, actinomycosis, typhoid fever, cholera, pyemia, septicemia, tetanus, sheep-pox, Texas fever, etc.

Toxins and Ptomains. Certain meats cause on ingestion toxic symptoms. These symptoms are due to toxic substances in the meat or to bacterial products of decomposition, called "ptomains." The symptoms resemble those of severe gastro-intestinal inflammation. The Bacillus botulinus has been regarded as the cause of some of the toxic effect of certain meats.

The severity of ptomaine poisoning by meat differs according to the condition of meat, the manner of preparation, the quantity ingested, and the individual idiosyncrasies of the victim. It is most frequently caused by the eating of "prepared meats," such as chopped meats, sausages, canned, "potted," and "deviled" meats, etc.

Causes of the Unfitness of Meat for Food. These may be: (1) the diseases of animals; (2) the unfit condition of living animals; (3) postmortem changes; (4) infection of the meat by persons or by places of manufacture, sale, etc., (5) adulteration.

Diseases of Food Animals. The diseases of food animals, which render their meat totally or partly unfit for food have already been enumerated.

The Condition of Food Animals. The conditions of food animals which may render their meat unfit for food are the following:

1. death from age, disease, or accident;

2. a moribund condition due to injury, drugs, overwork, fright, overdriving, etc.;

3. immaturity: unborn calves and lambs, and animals in the first few weeks of life are unfit for food.

4. artificial conditions and treatment of the carcass by blowing up (blown veal), coloring, etc.

Postmortem Changes. The temperature, moisture and substances of the slaughtered carcass make a favorable medium for the development of micro-organisms in the meat. The decomposition and organic changes resulting from their development necessarily cause the meat to deteriorate and render it unfit for food unless bacterial action is inhibited by placing the meat in a condition unfavorable to the development of bacteria or to putrefaction. The rapidity of deterioration depends on the condition of the animal from which the meat was obtained, the cleanliness observed in preparing it, and the cleanliness of the place in which it is kept.

Infection by Persons and Places. In addition to the foregoing sources of deterioration, meat may be directly infected with pathogenic and other bacteria by the persons who handle it and take part in slaughtering, skinning, dressing, cutting, manufacturing, packing it, etc.

The meat may also become infected in the various places through which it must pass in the process of manufacture.

Adulteration of Meat. Meat adulterations may consist of:

1. the addition of foreign substances reducing, lowering, or injuring the quality of the food;

2. the partial or entire substitution of an inferior substance;

3. the extraction of some of the valuable substances;
4. the coloring, coating, or the changing otherwise of the appearance of the food, concealing its poor quality or making it appear better than it is.

Characteristics of Good Meat. Good meat is uniform in color, neither too red nor too pale, firm and elastic to the touch, moist but not wet; it does not pit, nor crackle on pressure, and has a marbled appearance. It is free from unpleasant odor, its juices redden litmus paper slightly. The fat is firm and does not run. Beef is bright red, more marbled than any other meat. Veal is pale and less firm to the touch. Mutton is dull red, firm, and its fat white or yellowish. Horse meat is coarse in texture, dark in color, without layers of fat in the muscles; the fat is yellowish and runs down in drops when the carcass is hung up, and has a peculiar sweetish odor and taste.

Preservation of Meat. Postmortem putrefactive changes due to the development of bacteria can be prevented: (1) by rigid asepsis and the cleanliness of those who handle the meat and by careful attention to sanitation in the places where meat products are prepared. These prevent the bacteria from gaining access to the meat; (2) by the storage of meat under conditions that are unfavorable to the life and development of bacteria, namely: cold, dryness, and condimental or partly chemical preservation; (3) by the destruction of all the bacteria, i.e., by the sterilization of the meat by heat.

Cold Storage. Cold storage of meat does not kill bacteria, but inhibits their growth, and keeping meat in cold storage or freezing it may preserve it for a long

time. The common opinion that meat may be kept in cold storage indefinitely without injury is wrong, for meat certainly deteriorates if it is kept at a low temperature for more than two or three months. On thawing, frozen meats deteriorate very rapidly, and have been known to produce toxic symptoms on ingestion. As an auxiliary means of preservation for not too prolonged periods cold is valuable.

Drying. The drying of meat is an old method of preserving it, and is a valuable means of preserving the meat fibre, which should be rendered very dry, or reduced to powder. Drying may be accomplished in the sun, a very slow process, or it may be done artificially. Its usefulness is necessarily limited.

Condimental Preservation. Condimental preservation of meat consists in preserving it by the aid of salt, sugar, vinegar, and other condiments, either in dry form (with salt) or by the wet process (pickling in vinegar, etc.). These condiments do not kill the bacteria, but effectively stop putrefaction and may preserve certain meats for long periods.

Smoking. Smoking meat renders it not only comparatively dry but also impregnates it with the creosote of the smoke, which serves as a valuable means of preserving certain kinds of meat.

None of the above methods of preservation destroy parasitic ova, or all the pathogenic germs which may be in the meat, and all except cold render the meat less digestible, and somewhat alter its texture, appearance, and taste.

Chemical Preservatives. The use of chemical preservatives, such as borax, boracic acid, sulphite of

soda, and others, is very reprehensible, and is justly prohibited by federal and municipal sanitary legislation.

The objections against the chemical preservation of any food may be summed up as follows:

1. All chemicals used for preservation are more or less toxic, and their ingestion injurious to health, especially if habitually used.

2. By the use of chemical preservatives, inferior meats and products, and meats partly decomposed, may be so disguised as to be sold for fresh and unspoiled products.

Heat. Heat preservation of meat is the only effective and absolutely reliable method of preservation, because it kills and destroys all entozoa and pathogenic germs, and thus renders the product sterile and absolutely safe.

For domestic use the sterilization of meat is accomplished by roasting, baking, or boiling for from 15 minutes to an hour. *For commercial purposes the process of meat preservation* should include: (1) the destruction of all germs by heat, and (2) the enclosure of the product in hermetically closed sterile vessels in which further infection is prevented, thus permitting the food product to be preserved for indefinite periods. This process of meat preservation consists of "canning," and is accomplished in the following manner: (1) by the selection of appropriate meat; (2) by cutting this into appropriate pieces; (3) by parboiling, or exposing the meat in hot water under the boiling point for 10 to 20 minutes in order to shrink it and lessen its bulk; (4) by then putting it in cans or tins filled with salted soup or liquid, and soldering on the cover, leaving only

a small aperture for the escape of air; (5) by placing the cans next in boilers or steamers and subjecting to high heat for an hour or two; (6) by closing the openings left in the cover of the can and subjecting the cans to a steam bath for an hour or more according to the character of the product.

Sanitary Supervision, Prevention of the Adulteration of Meat. The strict sanitary supervision of all the various processes through which meat passes from the initial to the final stage is absolutely necessary in order to keep the food supply free from dangerous contamination and infections. Adulteration by substitution, palming off inferior products for superior ones, and adulteration with foreign ingredients, as well as by artificial preservation by means of chemicals, may be prevented only by a rigid, thorough, scientific, and prompt municipal or federal inspection by qualified and competent medical officers.

Poultry and Game. The flesh of all domestic fowls, such as chickens, turkeys, geese, ducks, and of some wild fowls is used for human food.

Vacher * gives the following characteristics of healthy poultry and poultry meats: "Healthy poultry are active, bright, dry in the eys and nostrils; their feathers are glossy and elastic, and the combs and wattles are firm and of brilliant red. Age is indicated by duskiness of the comb and gills, by dulness, fading, and brittleness of the feathers, raggedness of feet and by the size of the claws. Good poultry should be firm to the touch, pink or yellowish in color, fairly plump, should have a strong skin, and a fresh,

* Food Inspector's Handbook.

not disagreeable odor. Stale poultry loses firmness, becomes bluish in color, green over the crop and abdomen; the skin breaks readily, and the bird has a disagreeable odor."

"Drawn" or "undrawn" are terms used to indicate the removal or presence of the internal organs of the poultry offered for sale. Undrawn poultry decomposes sooner on account of intestinal putrefaction. Cold-storage undrawn poultry may become dangerous to health by its deterioration. As poultry can be obtained at all times there is no good economic reason why it should be placed in cold storage for long periods, and the practice is reprehensible. The practice of keeping poultry or game for a certain time until it is "ripe," or "gamey," and partly decomposed, is dangerous to health.

Forced feeding does not seem to produce any "pathological conditions in poultry, and even the "fatty liver" of forcibly confined and fed geese in the much prized delicacy "pâté de foie gras," does not seem to effect the gourmand injuriously. Live poultry is subject to many and various diseases, which render the meat unfit for use, and make necessary the rigid antemortem inspection of this as well as of other meats.

Fish Foods. A very large variety of sea and fresh water fishes are used for food. They are killed by deprivation of oxygen. Fish should be used in season, should be fresh, firm, and elastic to the touch. Fresh fish may be recognized by the rigor mortis, the freshness and red color of the gills, the moist, clear eye, and not disagreeable odor.

Frozen fish is not palatable, and decomposes very

rapidly on thawing. Many cases of poisoning, including ptomaine poisoning from eating stale fish, are on record.

The eating of certain shellfish, crabs, lobsters, and oysters is at times fraught with danger to health, and many cases of wholesale poisonings have been reported. Oysters are sometimes purveyors of typhoid fever, when they are grown near large towns in waters that are much contaminated by sewage containing typhoid germs. The danger from oysters is the greater in that they are very often eaten raw.

Fish are preserved by smoking, drying, salting, pickling, and by canning also.

The sanitation of the establishments where fish are prepared for canning should be as good as the sanitation of those where meat products are manufactured.

CHAPTER III

MILK AND DAIRY PRODUCTS

Importance of Milk as a Food. Of all the various foods used by human beings milk is the most important. Milk contains all the elements of food necessary for the nutrition of man, and contains these elements in a right proportion. Milk is the only food of millions of infants and children deprived of the breast; it is the principal food of the sick, of invalids and convalescents, and it is a part of the food of all people at all times.

Importance of the Milk Industry. According to the United States Agricultural Department there were on January 1, 1910, in New York State alone 1,800,000 milch cows. New York City alone consumes about 2,000,000 quarts of milk daily. There are nearly 1,000,000,000 gallons of milk sold every year in the United States, and the amount of capital invested in the dairy industry exceeds 1,000,000,000 dollars.

The great importance of milk and milk products as a food and the magnitude of the milk industry make it of paramount importance that they should reach the consumer in as clean and pure a state as possible. This, however, is almost impossible on account of: (1) the distance of the milk supply, (2) the time required for

transportation, (3) the nature of the product itself, and (4) the many sources of contamination.

Distance. In the milk supply of cities the distance of the producers from the consumers is necessarily great. New York City obtains its milk supply from about 44,000 farms located in six States within a radius of 400 miles from the city.

Time. The city consumer of milk hardly ever gets it before it is 24 hours old; often 36 and 48 hours elapse between milking and consumption.

Nature of Product. Milk being an opaque animal secretion voided at a temperature of the body, is easily contaminated with all kinds of impurities difficult of detection.

Sources of Contamination. These are very numerous. They may be the cow itself, the food and water it drinks, the stable, barnyard and surroundings of the cow, the pails, cans and various utensils used by the farmer, milkers, and handlers of the milk, and a great many others.

Character of Impurities. The impurities which are found in milk may be divided into two large groups: Dirt and Bacteria.

Dirt. By dirt is meant everything found in milk which is foreign to its composition, which is not milk, which is "matter out of place." The dirt may be mineral, vegetable, or animal. The mineral dirt consists mostly of dust, sand, clay and earthy particles, also of certain preservative salts used for increasing the keeping qualities of milk. Vegetable dirt is composed chiefly of particles of hay, straw, grain, seeds, flowers, etc. The animal dirt abundantly found in

milk consists chiefly of hair, feathers, manure, insects, flies, the ova of parasites, etc.

The amount of dirt found in milk is in direct ratio to the care taken in the production of milk. The amount is often very large. Most of the dirt may be seen readily at the bottom of vessels after the milk has been left standing for some time; it may also be readily obtained by the action of the centrifuge.

Bacteria in Milk. The most important impurities found in milk are bacteria.

Bacteria are minute vegetable micro-organisms invisible to the naked eye but discernible under the microscope, and are found everywhere. Bacteria come in various shapes, some round, others spiral, rod shape, etc., and are found clinging to soil, dust, dirt, rubbish, excreta, discharges, etc. They develop very rapidly under favorable conditions, millions of them growing out of one colony.

The importance of bacterial life lies in the fact that to them solely is due the process of putrefaction and decomposition of organic life and the disintegration of all organic matter.

Besides their putrefactive action bacteria may also play a more important role in the causation and transmission of disease.

Within the last several decades it had been definitely demonstrated that many diseases, the true causes of which were hitherto unknown, were directly due to the action of certain bacteria which upon gaining entrance into the human body cause certain pathological lesions resulting in certain groups of symptoms which we call by the names of various diseases. These

diseases are usually called "infectious," because they are caused by bacteria and may be transmitted from one person to another.

A large number of infectious diseases are known to be transmitted from one person to another by means of food, especially milk.

Disease Bacteria in Milk. A large number and many varieties of disease bacteria may be, and often are, found in milk.

The sources of the disease germs are the cows, their surroundings, their food and drink, the persons handling the milk, and the utensils in which it is kept, as well as the air with which it may come in contact.

Milk may also be contaminated by the common germs of putrefaction. These do not cause disease, but they may produce toxic elements in the milk which may harm the consumers and cause certain gastro-intestinal disturbances and "ptomain" poisoning.

The infective bacteria which may be transmitted by milk are those of the following diseases: diphtheria, scarlet fever, measles, tuberculosis, cholera, typhoid fever, dysentery, cholera infantum.

Milk and Infants' Diseases and Infant Mortality. The prevalence of gastro-intestinal diseases among infants and children especially during the summer months, is well known. Out of a total 105,553 deaths of infants in the United States during 1905, not less than 39,399 were due to gastro-intestinal diseases.

The difference in the death rates between breast-fed children and those fed on cow's milk in the New York Infant Asylum in 1902, was very great: 7.47 per cent in the former to 63.14 per cent for the latter. The

record of Rochester, N. Y., where Dr. Goler inaugurated a vigorous campaign on behalf of clean milk for children proves conclusively that a purer supply of milk will reduce not only the infant mortality during the summer months, but also the general death rate throughout the year.

In New York City the death rate of children under five years was reduced from 96.2 per 1000 during the whole year and from 136.4 during the three summer months in 1901 to 55 per 1000 during the whole year, and 62.7 during the summer months in 1906. This reduction is undoubtedly largely due to the cleaner milk which is at present supplied to the city and especially to the use of the Straus pasteurized milk among the poor classes of the city.

Milk and Diphtheria and Scarlet Fever and Measles. It is not difficult to understand how milk may be readily contaminated by the germs of these dreaded children's diseases. The farmer's children, or the children or employees of the milk dealers and sellers may suffer from one of these diseases and by their proximity to the milk, during acts of coughing, spitting, sneezing, or by the scaling of the skin, may contaminate the open cans of milk with the infective germ and thus transmit the disease to other children and people. A large number of scarlet fever and diphtheria epidemics have been directly traced to infected milk.

Milk and Typhoid, Cholera, and Dysentery. The infective germs of the various diarrheal diseases, like typhoid, cholera asiatica and cholera infantum, as well as of dysentery are found in the discharges from the bowels of infected persons. These discharges may

cling to the hand, clothes, etc., of those who handle milk and thus gain access to the milk, where these infective germs find a very favorable medium and are capable of developing and increasing in very large numbers. The most frequent way in which the germs of these diseases gain access to the milk is through water. The discharges of infected patients are often deposited upon the exposed ground, or in shallow privy vaults, cesspools, etc., from which they are washed off, seep through the ground and gain access to the rivers, lakes, ponds, or wells which serve as sources of water-supply on farms.

The typhoid bacillus has been demonstrated in milk and its vitality is so great that it retains its life for long periods. Hesse reports finding typhoid germs in sterilized milk after 4 months' time.

According to Whipple (quoted by Ward) "it has been estimated that in the United States at the present time about 40 per cent of the typhoid fever in the cities is caused by water, 25 per cent by milk."

Water infected with typhoid fever germs may also be used as a washing fluid for milk utensils, or it may at times be used as an adulterant.

Milk and Tuberculosis. Tuberculosis may be transmitted through milk because the tubercle bacilli which are the cause of the disease may be and are often found in milk. Hesse found that 16 per cent of the New York City milk supply contained tubercle bacilli, and according to the investigation of others the presence of the germs causing tuberculosis has been clearly demonstrated so as to be beyond dispute.

Where do the tubercle germs which are found in

milk come from? There is no doubt that some of these germs may come from accidental contamination from the outside. It is easy to see how persons who are afflicted with the disease may while handling the milk infect it with tubercle bacilli by coughing, spitting, sneezing; or the germs may be found in the dried dust floating around dairies, or deposited on the hands and clothes, etc., of the persons handling the milk.

There are also strong reasons for believing that a large or a considerable number of the tubercle germs found in milk are derived from the cow herself. Unquestionably a very large percentage of milch cows suffer from tuberculosis. According to many observers the average percentage reaches at least 25 per cent. This means that one cow in every four is affected. The disease is scattered over the entire country and there is hardly a herd that is completely free from its ravages.

The question whether a tuberculous cow gives milk containing tubercle germs has been decided affirmatively, at least in so far as it is now definitely known that cows suffering from advanced tuberculosis which involves the udder yield tubercular milk.

Cow's Milk

Definition. Milk is the lacteal secretion obtained by the complete milking of one or more healthy cows.

Composition. Milk consists of water in which certain solids are dissolved or suspended. The relative proportion of the solids to the water varies from 11 to 14 per cent to 86 to 89 per cent, with an average composition of 13 per cent solids and 87 per cent of water.

Solids. The *milk solids* consist of sugar, fat, proteids, and minerals. Milk also contains a certain amount of ferments, gases, and bacteria.

Milk Sugar (Lactose). Lactose is a sugar peculiar to milk, found in milk only and differing somewhat from sugrose, dextrose, and other sugars. Milk sugar is less sweet, less soluble, less subject to acid fermentation, has a specific gravity of 1.53, is soluble in 6 parts of cold and 2.5 parts of boiling water; undergoes lactic acid fermentation readily, but alcoholic fermentation with difficulty (Blyth). The average percentage of milk sugar in milk is about 5, varying but slightly from this.

Milk Fat. Milk fat consists of the glycerides of various fatty acids, volatile and non-volatile. It is found in the milk in the form of an emulsion consisting of very numerous minute fatty globules held in suspension in the whole milk.

The milk fat is the most variable part of the milk constituents. Its proportion varies between 2 and 6 per cent, with an average of 4 per cent.

Proteids and Albuminoids. The proteid matters in the milk consist of about 80 per cent of casein and 20 per cent of other albumins, such as lacto-albumins, protein, nuclein, etc.

The casein is the principal and most valuable proteid matter. Casein is coagulated by acids, by gastric juice, by rennet and by a variety of other substances; it is not precipitated or coagulated by heat which coagulates the lacto-albumins. The proportion of proteid matter in milk is less variable than that of fat. Its average is 3.25 per cent.

Mineral Matter. Milk contains various minerals in minute quantities. Milk ash shows the presence of potash, soda, lime, magnesia, chlorine, iron, certain acids, etc. The percentage of mineral matter in milk averages 0.75.

COMPOSITION OF AVERAGE MILK

Water..........	87 per cent		
Solids..........	13 per cent	Sugar..........	5.00 per cent
		Fat............	4.00 per cent
		Proteid........	3.25 per cent
		Mineral.......	0.75 per cent
			13.00 per cent

Ferments and Gases in Milk. Milk contains a number of ferments or enzymes (diastose, galactose, etc.) which are peculiar to every species of animal, and have some function in the digestion and nutritive quality of the milk.

Milk, when fresh, also contains some gases, such as oxygen, and carbon dioxide, due to the air it contains. Later the pressure of carbon dioxide may be due to fermentation.

Appearance, Color, and Reaction. Normal milk has a white, or slightly yellowish color; it is opaque, has a pleasant characteristic odor and a sweetish taste.

The reaction of milk is "amphoteric," i.e., slightly acid to litmus and alkaline to turmeric. The reaction becomes more acid with the advance of lactic acid fermentation; when milk becomes decomposed it develops ammonia and becomes alkaline in reaction.

Specific Gravity. The weight and density of milk are greater than of water inasmuch as most of the milk

solids are of a relatively greater weight and density than water.

The heavier and denser solids are the milk sugar, the proteid matter, and the mineral matter. Milk sugar, sp. gr. 1.55, proteids, 1.20 (Rubner). The only ingredient of milk which is lighter and less dense than water is the milk-fat (0.92).

If a liter of water at 60° F. (15° C.) weighs 1000 grams, a liter of milk at the same temperature will weigh from 1.028 to 1.032. The specific gravity of average milk is usually 1.029, with variations from 1.028 to 1.032.

Milk without fat (skim milk) will have a much greater specific gravity as the lighter part is withdrawn. The specific gravity of skim milk ranges from 1.035 to 1.040, according to the more or less thorough removal of the fat.

The specific gravity of milk is increased by low temperature, by the addition of solids, and by the subtraction of fat. It is decreased by high temperature, by the addition of water, and by the addition of fat.

Variations. Not only the quantity but also the quality and the relative amounts of the various milk ingredients vary greatly. Some of the factors on which the variation depends are: the breed of the cow, its age, kind, health, condition, care, food, drink, housing and treatment, the climate, time of year, time of day, period of lactation, season, weather, and many other factors too numerous to mention. Most of the variations produced by these factors are normal and expressed in the relative quantity of milk produced, or the relative

proportion of its various ingredients. Among the most important variations in milk are those which are found in colostrum, fore-milk, and the strippings.

Colostrum. For a certain period before and for several days after parturition the milk secreted by the cow differs materially in composition from normal milk. While most cows "dry up" or cease to give milk in the last months or weeks of pregnancy there are some which continue to produce milk until the last days of pregnancy. During the 10 days or 2 weeks before calving and from 3 to 5 or 6 days after, the milk derived from cows is called "colostrum," or commonly "beastings."

Colostrum differs in composition from normal milk in that it contains a relatively small percentage of water (about 75 per cent), relatively less milk sugar and milk fat, and relatively more proteid matter, not in the form of casein but of lacto-albumin. To the latter it owes its property of coagulation by slight heat a distinctive characteristic of colostrum. Colostrum also contains a considerable amount of blood corpuscles, and of the so-called "colostrum corpuscles." The color of colostrum is distinctly yellowish and reddish, the taste peculiarly sweetish and the odor specific. The ingestion of colostrum, especially when heated, is relished by a number of persons, although it has been known to cause gastric disturbances. The mixing of colostrum with the rest of the milk, or its sale is forbidden by most municipalities.

Foremilk and Strippings. There is a considerable difference in the relative amount of milk fat in the few streams of milk derived at the beginning of milking

from that of the few streams of milk derived at the end of the milking. The first milk called fore-milk contains sometimes less than 1 per cent of fat, while the last, called strippings contains sometimes over 5 per cent.

Abnormal Milk. Milk is sometimes abnormal in color, composition, etc., and the sale of such milk is usually forbidden.

Milk may be abnormal in color, distinctly red, blue, yellow, violet, etc. These abnormal colors of the milk are due to contamination with specific bacteria, which produce the changes in color.

The odor and taste of milk may also be abnormal. Thus milk sometimes is distinctly bitter or has the taste of garlic, onions, turnips, cabbage, etc.; it may bear some of the characteristic odors of strong vegetables, etc. Milk may also have a distinctly fermentative and "swilly" taste. Most of these deviations from the normal are due to the food ingested by the cow. The bitter taste may be due to bacterial action.

Milk may be abnormal in its consistency and become "slimy," "ropy," and viscous. In this condition it will not churn, nor will the cream separate, but otherwise it does not seem to be very harmful. The condition is due to the action of certain bacteria. Ropy milk is said to be a favorite article of food in Norway and elsewhere, and may be artificially produced by immersing the stem of "butterwort" in milk (Blyth).

Milk Products

A consideration of milk production and inspection is incomplete without reference to the most important

products which are a part of the milk industry. These are: cream, skimmed milk, butter, buttermilk, cheese, whey, condensed and evaporated milk, milk powders, koumis, kefir, etc.

Cream. Cream is the fatty portion of milk. It has the same composition as milk except that the percentage of fat is very much larger. The percentage of cream in milk may vary from 6 to 50 or 60, and depends upon the process of obtaining it from the milk. The average amount of butter fat in cream is 20 per cent; the United States standard is 18 per cent.

Production of Cream. Cream is found in milk in suspension in minute globules of varying size. It is separated from milk by two processes: The gravity method, and by means of the centrifuge.

Separation by aid of gravity is the oldest known process of gaining cream. It is based upon the fact that the suspended fat globules are of a lesser specific gravity than milk and rise to the surface when the whole fluid is left at rest. The common method is to pour the newly drawn milk into vessels and leave them standing for a period of 24 to 36 hours. The cream rises to the surface, and appears as a yellowish layer and may be accordingly removed from the milk. Gravity methods may be divided into two: the shallow pan and the deep vessel setting systems.

Cream is also separated by centrifugal force in special "separators" which remove all fat except one-tenth of 1 per cent which is left in the skim milk. This is an effective process of separation.

Skim Milk. Skim milk is a milk from which all or part of the cream has been removed. The amount of

fat remaining in skim milk depends upon the methods of separation and the thoroughness of these: it may vary from less than one-tenth of 1 per cent to more than 1 per cent. Skim milk has a white and somewhat bluish color, a high specific gravity varying from 1.035 to 1.040. Because of the proteids and casein it contains skim milk is a highly nutritious and valuable food. The sale of skim milk is prohibited in many cities, not because of any harm that it may do, but mainly on account of the ease with which it is substituted for whole milk and the difficulty of detecting the adulteration. The casein may be separated from the skim milk and used for commercial purposes, or it is used for the extraction of its milk sugar. Certain forms of cheese are largely made of skim milk.

Blended Milk. This term is applied to a modified milk in which one or more of the components of milk is increased or diminished so as to furnish a modified milk with the desired percentages of certain of the milk components. It is largely used for infant foods and manufactured according to formulæ prescribed by physicians.

Milk Powders. These are used chiefly as infant foods and are prepared by complete slow evaporation of the water of the milk. As a rule the powders are mixed with some sugar and cereal products.

Condensed Milk. Condensed milk is a milk from which a large part of the water has been extracted by slow evaporation. It is a very important article of commerce. Most of the condensed milk sold contains about 70 to 72 per cent of water with 28 to 30

per cent of milk solids to which cane-sugar is added to increase the keeping qualities. Some thickeners may also be used to give the condensed milk more "body." The condensed milk is sterilized and sold in hermetically-sealed tin cans. When mixed with water it has a sweet cooked taste.

Butter. Butter is the milk fat of the milk gathered into a mass and separated from the milk or cream by the process of churning. Beside the milk fat which it contains in the proportion of 80 or more per cent, butter also contains water and minute quantities of the other ingredients of the milk.

Butter is commonly made of cream which is for this purpose ripened or made to undergo a process of lactic acid fermentation which is supposed to give the butter its valued "flavor." A "starter" made of buttermilk or soured cream is used to produce the "ripening."

Butter is produced by churning or agitating the cream with paddles or spoons, in vessels, tubs, or barrels. These may be revolved by hand or machine power. The particles of fat adhere together and form distinct grains which are worked over, the buttermilk is removed by several washings of water and the whole turned into a mass by working and pressing together. The process of butter making requires attention to temperature and other factors, upon which the flavor and quality of the butter depend. Some salt is added to the butter.

Buttermilk. Buttermilk is the residue left after butter is made from milk or cream. It contains all the ingredients of milk except fat. It contains millions

of lactic acid germs, and is a valuable food for man and animals.

Cheese. Cheese is "the solid and ripened product made by coagulating the casein in the milk by means of acids or rennet."

Cheese is made of whole milk which has undergone some lactic acid fermentation. This milk is coagulated or rendered into two parts: one an insoluble semi-solid composition consisting of casein and fat, the other (92 per cent or nearly the whole amount) consisting of water, sugar, albumen and a large part of mineral matter. The insoluble part is pressed out of its water, and worked over by pressing, cutting as well as by the addition of certain ferments until the desired flavor and texture of the finished product is obtained. Cheese may be made of whole milk, of skim milk, and of milk to which cream has been added. The "rennet" which is added and used for the coagulation of the milk is an extract made from the fourth, or disgestive stomach of a young calf fed on milk.

There are many varieties and forms of cheese, depending upon the kinds of milk, temperature of fermentation, degree of acidity, manner of coagulation, kind of rennet, process of ripening, the specific "ripening" bacteria used, etc.

The liquid portion which is left after the insoluble part has been removed in the process of cheese making is called whey. It consists mostly of water, but contains small quantities of albuminous matter and the sugar and most of the mineral matter of the milk. Whey is used for the extraction of milk sugar, and is also a valuable food for domestic animals.

The casein of the milk which is extracted from skim milk is also used for various purposes in the commercial manufacture of sizing for paper, etc.

Standards. The relative composition of milk and some of its products given above are only the average composition, found after an examination of a great number of samples of milk, etc., with large variations in the relative composition. In order, however, to guard the welfare of the public and prevent substitution, adulteration, and the selling of inferior grades of products, municipalities, States, and the Federal government have instituted certain *minima* of compositions, or *standards* below which milk and its products must not go and must not be sold to the public.

The following are the United States Standards for milk, cream, etc.

	Solids. Per Cent.	Fat. Per Cent.	Solids Not Fat. Per Cent.	Water. Per Cent.
Milk	11.75	3.25	8.5	88.25
Skim milk	9.25			
Condensed milk	28.00	7.00	....	72.00
Cream	....	18.00		
Butter	....	82.50		
Cheese	....	50.00		

The New York State standard for milk was 12 per cent solids and 88 per cent water until 1910, when it was lowered by act of legislature to 11.5 per cent and 88.5 per cent.

The New York City standard for milk is 12 per cent solids, of which 3 per cent must be milk fat. Other States and cities have slight variations from these standards.

"Standards are based upon data representing materials produced under American conditions and are fixed as such that a departure from above or below the minimum limit they prescribe, is evidence that such articles are of inferior quality. The limits fixed as standards are not necessarily the extremes authentically recorded for the article in question, such extremes being due to abnormal condition as a rule." (Wiley.)

Official Definitions. The following are the official definitions of milk and its products according to the United States Department of Agriculture.

Milk. Milk is the fresh, clean lacteal secretion obtained by the complete milking of one or more healthy cows, properly fed and kept, excluding that obtained within 15 days before and 10 days after calving.

Blended Milk. Blended milk is milk modified in its composition so as to have a definite and stated percentage of one or more of its constituents.

Skim Milk. Skim milk is milk from which a part or all the cream has been removed.

Condensed or Evaporated Milk. Condensed, or evaporated milk is milk from which a considerable portion of water has been evaporated.

Buttermilk. Buttermilk is the product which remains when butter is removed from milk or cream in the process of churning.

Cream. Cream is that portion of milk, rich in milk fat, which rises to the surface of milk on standing, or is separated from it by centrifugal force.

Butter. Butter is the clean, non-rancid product made by gathering in any manner the fat from fresh or ripened milk or cream into a mass, which also con-

tains a small portion of the other milk constituents and may or may not have an addition of salt.

Cheese. Cheese is the sound, solid, and ripened product made from milk or cream by coagulating the casein with rennet or lactic acid with or without the addition of ripening ferments and seasoning.

Whey. Whey is the product remaining after the removal of fat and casein from the milk in the process of cheese making.

Kumiss. Kumiss is the product made by the alcoholic fermentation of cow's or mare's milk.

Kefir. Kefir is a product made by a specific yeast fermentation of milk.

Milk Adulteration

Milk is adulterated in several ways: (1) by addition of water; (2) by subtraction of cream; (3) by both addition of water and subtraction of cream; (4) by addition of coloring matter, thickening and certain harmless substances; (5) by addition of skimmed milk; (6) by addition of chemicals as preservatives.

Addition of Water. This is one of the most prevalent methods for the adulteration of milk. It is so easy, so apparently difficult of detection, and changes the appearance and general physical quality of the milk so little that it is often resorted to by dishonest dealers and producers. The addition of water to milk reduces its quality by diluting it. The whole mass is then less nutritious, and has fewer food ingredients than normal milk. This is a harmful adulteration because it reduces the quality of the milk, and when fed to children, must prove injurious to their health. It is also a fraudulent

adulteration because it substitutes an inferior product for the same price that the superior would sell for.

Extraction of Cream. The extraction of cream, or what is called "skimming" is also a frequent mode of milk adulteration. It is perhaps even more in vogue among dealers than simple watering, because it is so much more profitable and difficult to detect. A 40-quart can of milk which sells for $1.60 will bring the dealer but 16 to 20 cents of additional profit when he adds four or five quarts of water to the can. If, however, the dealer removes two of the six or seven quarts of cream which the can contains he gains the price of the two quarts of cream (40 to 60 cents), less the price of the two extracted quarts, which amount to only 8 cents. This shows that the skimming of milk is a very profitable procedure, even when it is but partial. Indeed, a great deal of the milk in cans which is sold at the markets and by grocers for a low price, is more or less skimmed.

Skimming and Watering. Skimming of milk makes it heavier by substraction of the fatty or lighter portion, thus increasing its specific gravity and density. A skimmed milk will read from 32 to 38 on the Quevenne's lactometer, and from 110 to 118 on the Board of Health lactometer, according to the amount of cream taken off. In order to disguise this higher specific gravity and to reduce it, dealers who make their own tests add sufficient water to reduce the density of the skimmed milk, so as to make the readings on the lactometer about normal, thus trying to deceive the inspector who relies too much on the lactometer examination alone.

Skimming, as well as skimming and watering, reduce

the nutritive quality of the milk and is a harmful, as well as a fraudulent adulteration.

Addition of Skimmed Milk. The addition of skimmed milk to normal milk reduces the quality of the whole milk and is harmful as well as fraudulent. One of the principal reasons for the prohibition of the sale of skimmed milk in some cities is the tendency of dealers either to sell skimmed milk for whole milk, or to reduce whole milk by the addition of the skimmed.

Addition of Coloring Matter and Other Harmless Ingredients. The addition of coloring matter is mostly practised to disguise the poor appearance of skimmed or watered milk and make it look richer. The coloring matter most commonly used is a vegetable coloring "annatto." The other colors used belong to the coal tar family (azo-colors) and are harmful in comparison to coloring with "annatto" which is harmless. Their detection is possible only by chemical test.

Sodium bicarbonate is sometimes added to milk which is beginning to turn sour, in order to disguise the acid taste. In small quantities the addition of soda is harmless, but the procedure is dishonest in that it is done for the purpose of palming off milk which is acid for fresh milk.

Thickeners are very seldom put into milk, more frequently into cream and condensed milk.

Addition of Chemicals. See page 242.

Milk Preservation

Milk Deterioration. Milk remains in a normal state for a comparatively short period, and important changes occur very soon.

If left undisturbed at the normal house temperature fresh milk shows some physical changes within 6 to 12 hours and by this time it has also passed through certain chemico-biological changes. The physical changes are limited to the separation of the fat globules and the separation of the cream layer at the upper portion of the vessel containing the milk. There is also a reduction of the temperature of the milk from that at which it was voided to the temperature of the room. The other changes which occur are a souring which is slight at first, and later increases. If milk is left at the same temperature for longer periods a distinct coagulation or curdling develops owing to the hardening and separation of the casein. At the same time there is some gas formation and a bitter taste in the milk may become noticeable. All these changes are included in the term "deterioration" of milk. These phenomena are only the outward and noticeable changes; the real physical, chemical, and biological changes are, of course, more complex, and cannot be so easily detected. To what are these changes in the milk due?

Causes of Deterioration. The separation of the cream is easily accounted for by the comparative lightness of the fat globules which coalesce and rise to the top. The other noted changes are due to the microorganisms. A perfectly sterile milk, that is, one absolutely free from bacteria, has never been obtained. Micro-organisms are found in the ducts of the teats and udder of the cow and even milk obtained by cannula already contains a certain number of germs. Immediately after secretion the milk begins to be contaminated with numerous germs from the air

in the stable, the hands of milkers, the udder and teats of cow, the surfaces of strainers, pails, etc., so that by the time the milk is taken out of the stable it contains a very large number of bacteria. The number of bacteria usually remains stationary for a few hours owing to the so-called "*germicidal*" power which the milk possesses at this initial stage of its existence outside of the cow. Sooner or later according to the state of the temperature, the bacteria begin to develop and multiply, so that after a certain time they are so numerous as to be counted by the million in the cubic centimeter.

The number of the bacteria is not the most important factor, but the importance lies in the *kinds* of the multiplying germs. The bacteria which get into and develop in milk are of several kinds.

In the first place are the group of the germs named "lactic acid" bacteria. By acting upon the lactose they convert it into lactic acid and thus favor the gradual souring which on reaching a certain stage, causes coagulation of the casein with consequent curdling of the milk. Another group is composed of the "gas-forming" or "aërogenous" bacteria which are said to cause the gas formation in deteriorated milk. The butyric and proteid-decomposing bacteria may also develop simultaneously with the lactic acid germs. There are numerous other germs which may at the same time act upon the milk. The lactic acid bacteria are important because they cause the souring of the milk and its subsequent curdling. As far as health and food value are concerned, lactic acid formation is not necessarily a harmful process. The ingestion

of even very large quantities may not be harmful to health, indeed, in many cases, it is even beneficial. Buttermilk and whey contain enormous quantities of the lactic acid germs but are drunk with profit to health. They also possess another beneficial action in that they counteract other, more harmful bacteria. While lactic acid fermentation is active and at its height it is germicidal to other bacteria, which cannot develop in an acid medium. It may, therefore, be said with truth, that the lactic acid fermentation process is not *per se* a harmful process.

The gas-producing, the butyric and proteid decomposing germs are of more importance to health, because they are of harmful character. They produce putrefaction and decomposition, they develop bitter taste and foul odors, and may also produce certain toxins, which may become very harmful to those ingesting the fluid.

Conditions Favoring and Retarding Bacterial Growth in Milk. In view of the rapidity of the growth and the various character of bacteria it is important to note the conditions which favor and retard their growth and development. Generally, low temperatures, very high temperatures, absolute dryness and certain chemicals are unfavorable to the life and growth of germ life.

Moisture and a temperature between 60 and 100° F. on the other hand are very favorable.

Dryness. Moisture is necessary to germ life, and bacteria develop very slowly, if at all, in a dry medium. It is, of course, difficult to obtain absolute dryness, which alone is inimical to bacterial life, but if milk is dried and kept in the form of a powder it may be pre-

served for some time, although this applies more to milk powder from skim milk than to powdered whole milk, as the cream is said to become rancid even in powder form.

Low Temperature. By low temperature is meant any temperature 50° F. and below to freezing point. A low temperature does not destroy, but stops growth and development of bacteria. Their number remains the same, but they are in stunned form, always capable of doing mischief, even under these conditions. Thus it is known that typhoid fever bacilli may be alive for long periods even in ice or frozen milk, that such milk may therefore produce the disease. While bacteria do not grow in frozen milk, they do grow in milk kept at temperatures between 34 and 50° F., but only very slowly. The varieties which grow at these low temperatures are not the lactic acid bacteria but those which are likely to do harm if the milk is kept too long at these temperatures. Milk kept at temperatures between 34 and 50° F. may be preserved for several days to a week and more, the lower the temperature, the longer. The milk will not become sour, but it may become unfit for use because of the development of the other bacteria and their products.

Mean Temperatures. The effect upon milk kept at temperatures between 50 and 100° F., varies according to the degree of temperature and depends upon the kind of bacteria which the temperatures favor in growth and development and multiplication.

Various bacteria have a different and varying point of thermal death, as well as a temperature at which growth and development are most abundant. Lactic

acid bacteria for instance develop most rapidly at a temperature of 60 to 70° F., at which they multiply more quickly than any other species. As their development is inimical to the growth of other germs, milk kept at 60 to 70° F. will sour and contain lactic acid bacteria to the exclusion of almost all others. At higher temperatures between 80 and 100° F., the lactic acid bacteria do not always gain a predominance, but often others, especially the gas-producing bacteria, gain the upper hand and then in addition to the acid bacteria the milk contains other less desirable germs.

High Temperatures. High temperatures, i.e., temperatures above 100° F. are inimical and unfavorable to the life and growth of bacteria and the various bacteria have their own thermal death point. Some are destroyed at temperatures from 120 to 140° F. kept up for a certain period; to destroy others requires a temperature above the boiling point of water for an hour or more. Except for a few species, bacteria cease growing when the temperature is raised above 100° F., and begin to die when it is above 120 to 140° F., according to time of exposure to heat. At higher temperatures the bacteria are more quickly destroyed and in less time. Bacteria which bear spores are the most difficult to kill, and sometimes must be subjected to a very high temperature for a long time before they are destroyed. Most of the active germs, including the pathogenic bacteria of most common diseases, like typhoid, diphtheria, and tuberculosis are killed at temperatures of 140° F., kept up for 20 minutes and at higher temperatures kept up for less time.

Milk Preservation by Cold. As previously indicated, cold, i.e., a temperature from 32 to 50° F., does not destroy the germs in milk but merely inhibits and stops their growth and multiplication and thereby keeps the milk from being soured and decomposed. The length of time for which milk may be preserved by cold depends upon the number and the kind of germs originally in the milk before its temperature was reduced. It may vary from 24 hours to a week; frozen milk has been known to keep for longer periods, and is an article of commerce in Siberia and other northern countries. While the souring of the milk is undoubtedly postponed, it is not certain that its decomposition by other bacteria is avoided. Thus milk kept under low temperatures may keep sweet, and yet at the same time develop dangerous qualities. The main advantage of cold as a preservative is that it does not change the appearance and composition of the milk, and is valuable as an aid to preserving clean milk for a moderately short time. It must always be remembered that none of the germs are killed by cold temperatures and that the pathogenic bacteria may be as active as in warmer raw milk. Infected milk is, therefore, a dangerous milk to drink while raw, even if kept in a cool state. *Cold is only a valuable aid in milk preservation, nothing more.*

Milk Preservation by Sterilization. Sterilization is the only method by which it is possible to make absolutely certain that milk contains neither bacteria nor their spores. It is the only method of preservation which rids milk of pathogenic bacteria.

Sterilization is defined as the "heating of milk to

the boiling point of water and above for a time sufficient to destroy all organic life and all bacteria and their spores."

Complete or *absolute* sterilization cannot be accomplished unless the milk is heated well above the boiling point—to 220 to 240° F.—in autoclaves, or sealed chambers under steam pressure, for a time varying from ½ to 2 hours. This is the only means which assures complete destruction of all spores and pathogenic spore-bearing bacteria, like those of tetanus, etc. Simple *boiling* is also sometimes called sterilization. While this kills most germs and even a few spore-bearing germs, it does not make certain that all spores have been killed.

The objections to sterilization of milk, complete as well as incomplete, by boiling, are that certain changes are produced in milk by the heat. The effects of boiling and sterilization are as follows:

(1) change in color due to the browning or caramelization of the lactose;

(2) change in taste, the milk receiving a different cooked taste;

(3) the destruction of all lactic acid bacteria, ferments, enzymes as well as all other germs in the milk;

(4) coagulation of the albuminoid matter in the milk.

The sum of these changes is that the milk is not only less tasty, but it is much less digestible and fit for food. For infant feeding it has been found not appropriate, and some observers claim that it may cause scurvy and rickets.

Milk Pasteurization. The word "pasteurization" has been so much used and misused that it is about time to discard it entirely, for it has no intrinsic meaning and simply confuses the minds of those who use it promiscuously. Pasteur's name is applied to a process which is variously carried out and not always with scientific accuracy. The official definition of the term is "the heating of milk to a degree of heat sufficient to kill all most active germs;" in general, the word is applied to any kind of heating of milk short of boiling. It is obvious that until a definite attempt is made to define the degree of heating and the time of heating and the exact procedure the term will embrace various meanings according to the whim and methods of each commercial or other concern using it.

As Rosenau (in Bulletin 41) truly says: "we should protest against a word which means a generality." And as Rosenau remarks the two main dominant factors that control the temperature and time at which the milk should be pasteurized are (1) "The thermal death points of pathogenic bacteria, and (2) the ferments in the milk." The aim and purpose of so-called pasteurization is (1) to kill all most active bacteria, especially pathogenic, (2) to leave the "ferments" unaffected, and (3) to change the milk as little as possible in its general appearance, taste, and digestibility. There is as yet no unanimity of opinion as to the degrees and time at which these conditions are reached. According to Rosenau a heating of milk for 20 minutes at a temperature of 140° F. absolutely destroys the tubercle bacilli, typhoid, diphtheria, dysentery, cholera, and other germs, but not all the necessary and valuable

ferments in the milk. Not only the bacteria but their toxins, especially those of diphtheria and tetanus, are likewise destroyed at such a heat. There are, however, certain spore-bearing bacteria and bacterial toxins which remain unaffected at these temperatures. These spore-bearing germs are fortunately rare.

Chemical Preservation. The difficulty of keeping milk sweet for a shorter or longer time after milking led to the use of chemical preservatives, and among those formerly used are borax, boracic acid, salicylic acid, peroxide of hydrogen, and formalin. At present the use of any chemicals for milk preservation is strictly forbidden, although it is still more or less practised in secret. Borax and boracic acid were used in quantities of ten grains to the quart of milk. When used either singly or in combination they may preserve the keeping quality of the milk for 24 to 48 hours. Salicylic acid is a more powerful preservative but its bitter taste makes it unfit for use except in very minute quantities. Formaline which is a 40 per cent solution of formaldehyde is a powerful disinfectant. Even very small quantities can greatly enhance the keeping qualities of milk. One part of formaline in 50,000 of milk, or about one teaspoonful to a 40-quart can of milk will keep the milk sweet for 24 to 48 hours. The objections to chemical preservation are the following:

(1) The chemicals referred to are poisonous and injurious to human health even in minute doses. As they are injurious to adults, it is apparent that they must be even more harmful when ingested by delicate or sickly infants for whose use most of the milk is intended.

(2) They change somewhat the digestibility of the milk. This is notably the case with formaline, which hardens the proteid matter.

(3) A continuous and steady use of these chemicals will result in gastro-intestinal disturbances and intoxication, especially in children.

(4) The use of chemicals, once permitted, even in minute doses, is bound to produce carelessness on the part of producers who will rely more upon the keeping qualities of the chemical than upon the cleanliness of production.

(5) As soon as chemical preservation of clean and good milk is allowed, it is impossible to prevent the use of chemicals in the case of bad, old, and partly spoiled milk, and this increases the danger of the use of milk.

The use of *harmless* preservatives has also been urged. Among these are peroxide of hydrogen, oxygen, and carbon dioxide. Peroxide of hydrogen is used in the amount of about two ounces to the 40-quart milk can. It destroys most of the bacteria and at the same time disappears itself in the form of free oxygen. The use of hydrogen peroxide has not been tried extensively. The chemical is comparatively expensive and its value as a preservative is problematic. Oxygen has been advocated as a disinfectant in milk; it is perfectly harmless and escapes after destroying the germs. The expense and the lack of proper apparatuses have so far made this process impracticable. Carbon dioxide is said to destroy most germs in the milk when used under pressure of 75 pounds; the gas is harmless, does not change the character of the milk, and may be removed

by aëration. This process is being exploited by a commercial concern, but its scientific and practical value still remains to be demonstrated.

Milk Inspection and Testing

Methods of Examination and Testing. The methods of examining and testing milk for the different impurities it may contain, and of detecting the adulterations to which it is often subjected are physical, chemical, and bacteriological.

Physical Examination. By the physical examination the appearance, color, odor, and specific gravity of the milk, together with the variations from the normal are determined.

Chemical Examination. This determines the exact amount of solids in the milk, also the exact percentage of each solid in the fluid.

Bacteriological Examination. This determines the number of bacteria in the milk and the presence or absence of pathogenic bacteria.

Precautions. The precautions in taking samples of milk to be tested are: (1) that the milk is thoroughly mixed; (2) that it is not partly frozen; (3) that the milk to be tested is not partly churned, or partly separated from its cream, and also (4) that it is not partly or wholly coagulated.

Partly frozen milk will not give a good test, because the frozen part represents the watery part of the milk, and the rest of the milk will show a richer fluid and a higher percentage of solids.

Milk which has been partly churned and has butter

granules floating in it, or milk from which the cream has been wholly or partly separated will naturally not give the normal percentage of fat in the fluid, and the sample of the milk taken may not be a fair sample of the whole fluid.

A milk which has been partly or wholly coagulated will not give a fair sample for testing because of the separation of the whey and solids.

Before samples are taken milk which is partly frozen must be thawed, so that the whole fluid becomes uniform; milk which has been partly churned and contains butter granules floating in it must be heated, so that these granules melt; milk which has been partly or wholly coagulated must be treated with alkalis sufficient to dissolve the coagulum; a milk which has been partly separated from its cream must be thoroughly mixed and made uniform. In mixing milk care must be taken not to stir it too violently, so as not to churn the milk or to mix it with air. The best means of mixing milk and getting a uniform mixture is by pouring from one vessel to another.

Physical Examination. The physical examination of milk is of very great importance, and may give valuable information to the inspector. The color of the milk, its opacity, its resistance to the immersion of a lactometer, its adherence to the instrument, the visibility of the instrument through the glass test-tube, are all valuable indications in the hands of an experienced inspector. Milk which is bluish in color, which allows the lactometer to sink with little resistance, which runs down the instrument in thin bluish streaks, which hardly adheres to the instrument and which,

is so little opaque that the instrument is readily seen through the test-tube, is a milk which is poor in solids and which is probably either skimmed or watered, or both skimmed and watered.

Cream Gauge. Milk is often tested by the cream gauge, pioscope, and lactoscope. The cream gauge is simply a graduated glass test-tube in which the milk to be tested is allowed to stand for 24 hours. At the end of this time the amount of the cream, as indicated in the yellowish layer on top, is read off. A good milk usually shows about 14 per cent of cream. In order to facilitate the better separation of the cream, the milk is mixed with an equal amount of water and the resulting layer of cream is multiplied by two to show the actual amount of cream in the milk. The milk in the gauge should be put in a cold place, which favors the separation of the cream. This is a test upon which not much reliance can be placed.

Pioscope. The pioscope (Heeren) is a small ingenious instrument to test the quality of milk by its opacity and color. The instrument consists of a small rubber disk with a small depression in its centre, and of a glass plate painted in segments of varying shades of color representing the color of cream, rich milk, normal milk, poor milk, skimmed milk, watered milk etc. The inspector takes a drop of the milk to be tested and places it in the central depression of the hard rubber disk, covers it with the glass plate, and compares the opacity and color of the milk with the various segments in the circle. In the hands of an experienced inspector this is a fairly trustworthy test.

Lactoscope. The lactoscope (Feser) also tests the

milk by its opacity. The instrument consists of a graduated glass cylinder, in the centre of which, at the bottom, is fixed a small white rod with several black lines on its face; 4 c.c. of the milk to be tested are put into the cylinder, making the black lines on the rod invisible through the opacity of the milk. The test consists in carefully measuring the amount of water needed to be put into the cylinder to render the fluid transparent, so as to make the black lines upon the rod visible. It is obvious that the poorer the quality of the milk the less water it will be necessary to add to the cylinder in order to make the mixture transparent; and, on the contrary, the richer the milk, the more water it will be necessary to add. The instrument is graduated and shows the amount of estimated fat in the milk according to the number of cubic centimeters of water added.

Specific Gravity. The testing of milk by its specific gravity is the test most frequently employed, and is very valuable in conjunction with the general physical examination of the milk.

The specific gravity of milk depends on the solids in the fluid. Of these solids, sugar and the proteids are heavier than water, while the fat is lighter. The specific gravity of average normal milk is 1029, and may vary in normal milk between 1029 to 1032. Milk has the above stated specific gravity at 60° F.

Milk having a higher temperature than 60° F. will have a specific gravity above 1032, while colder milk has a specific gravity much less than 1029.

Milk which has been skimmed, i.e., from which a part or the whole of the cream has been separated

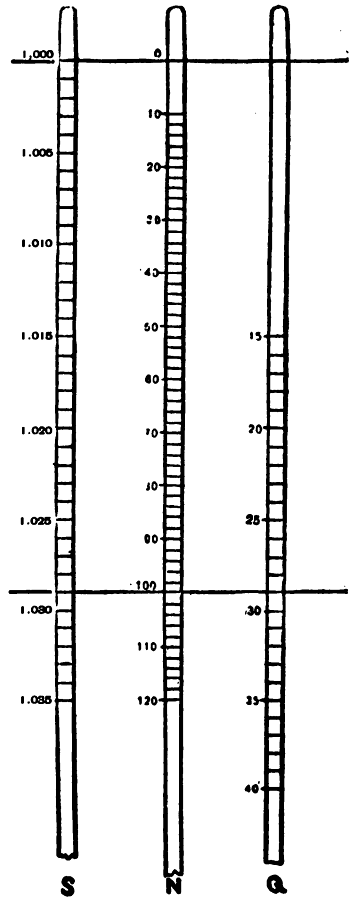
will show an increased specific gravity, because the absence of the fatty portion will make it denser and heavier. A milk which is diluted with water will show a decreased specific gravity because it is made thereby much less dense and thinner.

Quevenne Lactometer. The testing of milk with the Quevenne lactometer is based upon the relative specific gravity of the milk. This lactometer is graduated from 15 to 40, the scale reading as in ordinary hygrometers and showing the corresponding degree of specific gravity. A good milk will read (at 60° F.) 32 upon this lactometer, showing a specific gravity of 1032, and average standard milk will read 29; a watered milk will read less than 29, according to the amount of water (0 being water), while a skimmed milk will read more than 32, up to 40, according to the amount of cream subtracted.

Lactometer of the Health Department of New York. This instrument, extensively used in many places in the United States, is a larger instrument and is graduated differently from the Quevenne lactometer. According to this instrument it is assumed that 1029 is the lowest permissible specific gravity of standard milk and these 29 degrees, divided into 100 subdivisions from the top figure 0, showing the reading of water at 60° F., to 100, which will correspond to 29 on the Quevenne instrument, or 1029 specific gravity on the ordinary hygrometer. The lactometer is graduated from 0 to 120. According to the Board of Health lactometer a poor market milk will read 100, a good rich milk will read between 100 and 110, a skimmed milk will read between 110 and 120, while a watered

milk will read under 100, the amount of water added being indicated in the reading, i.e., 10 per cent of water being added if the lactometer reads 90°, 25 per cent at 75°, etc. This instrument is more convenient for use, as the stem is longer and the degrees may be read more readily, and also the exact amount of water to be added may be more readily calculated.

As the lactometric readings are calculated at 60° F., corrections must be made for any difference in the temperature of the milk above or below 60° F. When the difference in the temperature is very great, it is best to reduce or increase its temperature to within 10° of 60°. The correction for the temperature is the 0.1 degree of the Quevenne lactometer for every 1 degree of temperature, and 0.3 degree of the Board of Health lactometer for every 1 degree of temperature above or below 60°;



"S" Specific Gravity Scale.
"N" New York State.
"Q" Quevenne.

FIG. 25.—STEMS OF LACTOMETERS.

added to the reading when the temperature of the milk is above 60° F., and subtracted from the reading when the temperature of the milk is below 60° F. The usual rough correction for the Board of Health lactometer is 4° on the lactometer for every 10° on the thermometer, added or subtracted accordnig as it is above or below 60° F.

As the specific gravity of milk is increased by skimming and decreased by watering, some milk dealers first subtract a certain amount of cream, thus increasing the specific gravity and lactometer reading, and then add sufficient water again to decrease the specific gravity and lactometer reading to about normal, so as to deceive the inspector and give an adulterated milk a normal reading on the instruments. The only recourse of the inspector is then to compare the physical appearance of the sample of milk with normal milk; the difference in the color, opacity, and density of the fluid will then appear.

Chemical Examination. The chemical tests of milk consist in the examination for the exact percentage of solids and for the amounts and percentage of each component solid. The usual tests are those of weighing and evaporation for the exact amount of solids, and the Babcock test for the determination of the amount of fat in the milk. For the complete chemical and bacteriological tests of milk the student is referred to special works on these subjects.

The Sanitary Production of Clean Milk

The best means to prevent the spread of disease and the ill effects from impure milk is a thorough system of sanitary production of milk and its sanitary supervision from the time it leaves the milked animal to the time it reaches the consumer.

The production of clean milk embraces the proper regulation of the following *major sanitary details in its production and marketing:*

The water supply and drainage of the farm.
The surroundings, barnyard, and stabling of the cows.
The care for the health and the feeding of the cows.
Milking, milkers, and care of milk.
The regulation of dairies, bottling and milk establishments.

Water-supply and Drainage of Dairy Farms. The close relations between drainage, water-supply, and clean milk make it imperative that provision be made for the efficient and sanitary removal of all waste matters, and also for a pure uncontaminated water-supply.

Privy vaults and leeching cesspools should not be allowed at all on dairy farms, a proper disposal of sewage on such places being some form of irrigation, surface or subsurface, or earth closets and the removal of all fluid sewage to distant fields and gardens.

Manure should not be allowed to accumulate in barnyards and stables, but should be collected twice daily, pressed into barrels, or removed into distant parts of the fields, upon which it may be spread pro-

vided the drainage of such fields will not contaminate the sources of the water-supply.

No sources of water-supply should be situated within several hundred yards of stables, barnyards, privy vaults, or cesspools, or anywhere where they may receive the drainage from the same. Ponds, small surface collections of water, rivers which are contaminated by sewage and surface drainage, and shallow wells should be not relied on for the supply of water for the dairy farm; and cisterns, springs, and deep wells, when used, should be protected from contamination by sewage, and properly constructed, covered, and cared for.

Surroundings, Barnyard, and Stables. All places where milk animals are kept and their surroundings should be kept free from manure, dirt, refuse, and stagnant pools of water, nor should they be situated near marshy or water-logged ground.

Barnyards should be located on elevated ground, with sloping sides to facilitate drainage, and should be used exclusively for the cows, no other domestic animals being allowed within, nor should they have accumulations of dirt and refuse or stagnant pools of water.

Stables should be specially constructed for the purpose. One-story buildings of brick or concrete are best; no open second-story haylofts should be allowed, nor any cellars or manure pits under the stables. When stables are constructed several stories high, each floor should be separated with dust-tight floors.

Floors are best constructed of bricks laid in cement mortar, or of concrete with cement top, or of tiles—never of dirt or wood.

Walls and ceilings should be covered with hard plaster

on their inner surfaces and whitewashed, or painted with light-colored oil paint.

The floors should be properly graded to one point, where they should be drained into a sewer, if there is one or into a distant cesspool, properly cleansed, emptied at certain intervals, and cleaned and disinfected.

Single stalls should be of at least the following dimensions: $3\frac{1}{2}$ feet wide, 7 feet long, 9 feet high; and should be provided with iron stanchions for securing the cows. The mangers at the head of the stalls are best constructed of concrete, without nooks and corners, being thus easily washed and cleaned. At the foot of all stalls there should be provided a gutter, or valley drain, of iron or concrete, for the receiving of urine, etc., and such gutter should be covered with a removable perforated cover, such gutters to be graded and drained into the sewer or cesspool.

There should be at least 600 cubic feet of space for each cow in the stable, and proper provisions should be made for the entrance of fresh air through lowered openings and windows.

There should be a window or skylight for every 20 feet or fraction thereof of the length of the stable, and there should be at least 4 square feet of glass surface for each cow.

It is best to have in the stable separate compartments, unconnected with the general stable, for cows that are sick or parturient.

No water closets, privies, etc., should be located within the stables, nor should pigs or other domestic animals be allowed within the barnyard or stable premises.

Stable doors and windows should be provided with screens to prevent flies and mosquitoes from annoying the cows.

The walls, floors, ceilings, and all parts of the stables should be cleaned daily with water. The stables should be periodically emptied, so as to be thoroughly aired, and disinfected with solutions of lime, bromine, or formaldehyde.

Care, Health, and Feeding of Cows. No milk should be taken from cows that are suffering from general diseases, from cows that are greatly emaciated, that are overdriven, overexercised, or frightened, nor from cows that suffer from some local septic disease of the teats or udder.

Special care should be taken to detect cows that are suffering from tuberculosis, and to exclude such cows from the herd. Cows should be tested with tuberculin by competent veterinarians at stated intervals, and all cows which react to the test excluded and destroyed.

Daily examination of the cows for any abnormalities and signs of incipient disease should be a routine procedure of the caretaker of the animals.

Cows must not be abused, overdriven, or allowed to be annoyed by flies or domestic animals. They must be protected from too glaring sunshine, from rain and storm, must be kept in the pasture, in the fresh air, and exercised daily.

Proper provision for a supply of pure water should be made, and cows should be fed on fresh hay, grass, corn, and whole grains, but no ill-smelling, fermented vegetables, worm-eaten fruit, strong-smelling vegetables, weeds, brewery swills, marsh grass, sour ensilage,

nor any foul food should be given to cows. Salt should be accessible at all times.

Cows should be cleaned, brushed, and groomed daily, and the under surface of body, the abdomen, and flanks should be washed with warm water immediately before milking and wiped with a damp cloth. The hair on the tail and around the udder should be clipped short.

The air of stables at milking time should be free from dust or offensive odors, and no sweeping or disturbing the manure should be done immediately before or during milking.

Milkers, Milking, and the Care of Milk. Milkers should be free from general and local diseases, should clip their nails, scrub their hands, and wash them before milking, and should wear special clothes, caps, overalls, which should be white and clean, and not be used for any other purpose or at any other time.

The milking should be done with dry hands, evenly, quietly, gently, cleanly, and thoroughly, and at about the same time and by the same persons every day.

The first few streams of milk—the foremilk, should be discarded. It is very poor in fat and contains very many germs; also any milk which looks abnormal in color or consistency should be rejected.

If part of the milk is accidently contaminated with dirt or flies, etc., it should be rejected, and not mixed with the rest of the milk.

Narrow-mouthed, partly covered pails are preferred for milking, and sterilized gauze or cotton should be put over the metal strainers.

Pails and other utensils should be rinsed in warm

water, scrubbed with an alkaline solution and water, scalded with hot water, and boiled or sterilized in a steam sterilizer.

No loud talking, sneezing, coughing, tobacco spitting, or general expectoration should be allowed during milking.

The straining and cooling of the milk after milking must not be done in the stable. Separate, independent milk houses, specially constructed for the purpose, separate from any other building or the living house, should be provided for the handling and keeping of the milk from the time it is taken from the stable to the time of its removal to market, such milk houses to be free from any domestic animals, clean, without dust and dirt, the inner surfaces of walls and ceilings clean and whitewashed, the floor hard and cleansible, and provided with plenty of natural light for ventilation.

The straining of the milk must be done carefully and aseptically, and any machinery used for aëration or cooling be kept clean and in sanitary condition.

When the milk is cooled by immersion in tubs of running water, care must be taken that no water gain access to the milk.

The temperature of milk must be rapidly reduced to 45° F.

Regulation of Dairies, Bottling Establishments, and Stores. Dairies and creameries must be well lighted and ventilated, the inner surfaces of walls clean, whitewashed, or painted with light-colored oil paint, so that they may be washed with hot water. The floors are best made of concrete, tiles or stone laid in cement

mortar, and the establishments used for no other purpose except the handling of milk and its products.

No bottling should be done anywhere except in establishments specially fitted for the purpose.

Bottling machines should be made entirely of metal, with no rubber about them, and should be sterlized in a closed steam sterilizer before every bottling.

Milk cans should be of metal, or glass, with smooth joints, without seams, nooks, or corners, bottles should be of the variety called "common sense," and be capped with sterilized paraffined paper disks.

Cans, bottles, and all other milk utensils should be cleaned by first being thoroughly rinsed in warm water, then washed and scrubbed with a stiff brush and soap, or other alkaline solution, and hot water, and after that, being sterilized by boiling or in steam sterilizers, they must be dried and kept inverted in free air and clean places.

Stores in which milk is sold and handled should be clean, their walls and ceilings whitewashed, and floors well-scrubbed and clean. The milk cans should be kept at a distance from foul and strong-smelling vegetables, and foods should be kept at the temperature of 45° F., and the can covered at all times, and the milk should be stirred before each sale.

No sleeping should be allowed on the premises, nor should there be any communicating doors or openings between the store proper and living rooms, and no children or domestic animals should be allowed in the store or near the milk vessels.

The refrigerator where milk and its products are kept should be clean and free from foul odors, and the

waste from said refrigerator, when not otherwise properly connected, should be made to discharge into a properly trapped, sewer-connected, water-supplied open sink in the cellar or the store.

During transportation milk should be kept refrigerated, and the temperature not over 50° F., and the cans should be full, well covered, and the milk protected from too much agitation and churning.

Cans and bottles should be labelled with the name of the wholesale dealers, as well as with the name of the dairy from which the milk is derived, with the date of milking, and if pasteurized, with the date of pasteurizing them.

Regulation of Sale of Milk in New York City

The following excerpts show the methods adopted by the New York Department of Health to regulate the sale and supply of milk.

Sections of the Sanitary Code as Amended by the Board of Health January 4, 1912, to Make Effective the New Classification of Milk Sold in New York.

All milk held, kept, offered for sale or sold and delivered in the City of New York shall be so held, kept, offered for sale or sold and delivered under either or any of the following grades of designations, and under no other, and in accordance with such rules and regulations as may be adopted by the Board of Health, namely:

Grade A—For Infants and Children:

1. Certified or guaranteed milk.
2. Inspected milk (raw).
3. Selected milk (pasteurized).

Grade B—For Adults:

1. Selected milk (raw).
2. Pasteurized milk.

Grade C—For Cooking and Manufacturung Purposes Only.

Raw milk not conforming to the requirements for Grades A and B.

Condensed skimmed milk.

Condensed or concentrated milk.

The provisions of this section shall not apply to buttermilk or to milk products commonly known as Kumyss, Matzoon, Zoolak, dried milk or milk powder, or to other similar preparations, or to cream or modified milk.

No milk shall be held, kept, offered for sale or sold and delivered in the City of New York under either or any of the designations known as Grade A, B or C, or any of the subdivisions thereof, or any of the designations condensed skimmed milk, condensed or concentrated milk, or modified milk, without special permit in writing therefor from the Board of Health, subject to the conditions thereof.

The special permit shall specify the grade of subdivision thereof, or the special designation of milk, which the holder of such permit is authorized to keep for sale, or offer for sale, as aforesaid.

None of the provisions thereof, however, shall apply to condensed milk when contained in hermetically sealed cans.

Rules and Regulations of the Department of Health Relating to the Sale of Milk as Amended by the Board of Health, January 4, 1912, to Conform to the New Classification of Milk.

Grade A.

FOR INFANTS AND CHILDREN

Guaranteed Milk

Definition—

Guaranteed milk is milk produced at farms holding permits therefor from the Board of Health, and produced and handled in accordance with the following minimum requirements, rules and regulations:

Requirements, Rules and Regulations—

1. Only such cows shall be admitted to the herd as have not re-acted to a diagonstic injection of tuberculin.

2. All cows shall be annually tested with tuberculin, and all re-acting animals shall be excluded from the herd.

3. No milk from re-acting animals shall be shipped to the City of New York for any purpose whatever.

4. The milk shall not contain more than 30,000 bacteria per c.c. when delivered to the consumer, or at any time prior to such delivery.

5. The milk shall be delivered to the consumer only in sealed bottles, which have been sealed at the dairy.

6. The milk shall be delivered to the consumer within 30 hours of the time at which it was drawn.

Certified Milk

Definition—

Certified milk is milk certified by a milk commission appointed by the Medical Society of the Country of New York, or the Medical Society of the County of Kings, as being produced under the supervision and in conformity with the requirements of that commission as laid down for certified milk, and sold under a permit therefor issued by the Board of Health.

No milk shall be held, kept, offered for sale, or sold and delivered as certified milk in the City of New York which is produced under requirements less than those for guaranteed milk.

Inspected Milk—Raw

Definition—

Inspected milk (raw) is milk produced at farms holding permits therefor from the Board of Health, and produced and handled in accordance with the following minimum requirements, rules and regulations:

Requirements, Rules and Regulations—

1. Only such cows shall be admitted to the herd as have not re-acted to a diagnostic injection of tuberculin.

2. All cows shall be tested annually with tuberculin, and all re-acting animals shall be excluded from the herd.

3. No milk from re-acting animals shall be shipped to the City of New York for any purpose whatsoever.

4. The farms at which the milk is produced must obtain at least 75 points in an official score of the Department of Health. These 75 points shall be made up as follows: A minimum of 25 points for equipment, and 50 points for method,

5. The milk shall not contain more than an average of 60,000 bacteria per c.c. when delivered to the consumer, or at any time prior thereto.

6. Unless otherwise specified in the permit, the milk shall be delivered to the consumer only in bottles.

Selected Milk—Pasteurized

Definition—

Selected milk (pasteurized) is milk produced at farms holding permits therefor from the Board of Health, and produced and handled in accordance with the following requirements, rules and regulations:

Requirements, Rules and Regulations—

1. The farms at which the milk is produced must obtain at least 60 points in an official score of the Department of Health. Of these 60 points, a minimum of 20 points shall be required for equipment and a minimum of 40 points for method.

2. All milk of this grade shall be pasteurized, and said pasteurization shall be carried on under a special permit issued therefor by the Board of Health, in addition to the permit for " Selected Milk (Pasteurized.) "

3. The milk shall not contain more than an average of 50,000 bacteria per c.c. when delivered to the consumer, or at any time after pasteurization and prior to such delivery.

4. Unless otherwise specified in the permit, the milk shall be delivered to the consumer only in bottles.

5. All containers in which pasteurized milk is delivered to the consumer shall be plainly labeled " Pasteurized." Labels must also bear the date and hour when pasteurization was completed, the place where pasteurization was performed, and the name of the person, firm or corporation performing the pasteurization.

6. The milk must be delivered to the consumers within 30 hours after the completion of the process of pasteurization.

7. No milk shall be pasteurized more than once.

8. No milk containing in excess of 200,000 bacteria per c.c. shall be pasteurized.

General Regulations for Grade A—

1. The caps of all bottles containing milk of Grade A shall be white, and shall contain the words " Grade A " in black letters, in large type.

2. If cans are used for the delivery of milk for Grade A., the said cans shall have affixed to them white tags, with the words " Grade A " printed thereon in black letters, in large type, together with the designation " Inspected Milk (Raw) " or " Selected Milk (Pasteurized)," as the quality of the contents may require.

Grade B

FOR ADULTS

Selected Milk—Raw

Definition—

Selected milk (raw) is milk produced at farms holding permits therefor from the Board of Health, and produced and handled in accordance with the following minimum requirements, rules and regulations:

Requirements, Rules and Regulations—

1. Only such cows shall be admitted to the herd as have been physically examined by a regularly qualified veterinarian and declared by him to be healthy, and free from tuberculosis in so far as a physical examination may determine that fact.

2. The farms at which the milk is produced must obtain at least 68 points in an official score of the Department of Health. These 68 points shall be made up as follows: A minimum of 25 points for equipment, and a minimum of 43 points for method.

3. The milk shall not contain an excessive number of bacteria when delivered to the consumer, or at any time prior thereto.

Pasteurized Milk

Definition—

Pasteurized milk (Grade B) is milk produced under a permit issued therefor by the Board of Health, and produced and handled in accordance with the following minimum requirements, rules and regulations and in further accordance with the special rules and regulations relating to the pasteurization of milk.

Requirements, Rules and Regulations—

1. The milk after pasteurization must be at once cooled and placed in sterilized containers, and the containers immediately closed.

2. All containers in which pasteurized milk is delivered to the consumer shall be plainly labeled "Pasteurized." Labels must also bear the date and hour when the pasteurization was completed, the place where pasteurization was performed, and the name of the person, firm or corporation performing the pasteurization.

3. The milk must be delivered to the consumer within 36 hours after the completion of the process of pasteurization.

4. No milk shall be pasteurized more than once.

5. No milk containing an excessive number of bacteria shall be pasteurized.

General Regulations for Grade B—

1. Caps of bottles containing milk of Grade B shall be white and marked "Grade B" in bright green letters, in large type.

2. The necks and shoulders of cans containing milk of Grade B shall be painted bright green, and a metal tag shall be affixed to each can with the words "Grade B" in large type, and the words of the subdivision to which the quality of the milk in the said can conforms.

Grade C

FOR COOKING AND MANUFACTURING PURPOSES ONLY

Definition—

Raw milk not conforming to the requirements of any of the subdivisions of Grade A or Grade B.

1. The caps of all bottles containing milk of Grade C shall be white and shall contain in red the words "Grade C" in large type and "for cooking" in plainly visible type.

2. Cans containing milk of Grade C shall be painted red on necks and shoulders and shall have in red the words "Grade C" in large type and "for cooking" in plainly visible type, affixed to each can.

All creameries handling milk of different grades will be required to demonstrate to the Department of Health that they are capable of keeping the grades separate, and must keep records satisfactory to the Department of Health concerning the amonut of milk of each grade handled each day.

Condensed or Concentrated Milk

Definition—

This is milk of any grade or subdivision thereof from which any part of the water has been removed, or from which any part of the water has been removed and to which sugar has been added.

Rules and Regulations—

Milk of this designation shall be sold only under a permit issued therefor.

General Rules and Regulations

Permits

1. A permit for the sale of milk or cream, of any grade or designation, may be granted only after an application has been made in writing on the special blank provided for the purpose.

2. A permit for the sale of milk, of any grade or designation, or of cream, may be granted only after the premises where it is proposed to care for and handle such milk shall have been rendered clean and sanitary.

3. Every permit for the sale of milk, or cream, from places other than wagons, shall expire one year from the date of issue.

4. No wagon shall be used for the transportation of milk, condensed milk, or cream, without a permit from the Board of Health. Every such permit shall expire on the last day of December of the year in which it is granted. A wagon permit for the sale or transportation of milk,

condensed milk, or cream shall be conspicuously displayed on the outside of the wagon so that it may be readily seen from the street.

5. Every permit for the sale of milk of any grade or designation, in a store, shall be so conspicuously placed that it may be readily seen at all times.

6. All stores selling or keeping for sale milk, condensed milk or cream will be frequently inspected and scored by a system adopted by the Department of Health, and the revocation of the permit of any store may ensue if the score is found repeatedly below the required standard.

7. The revocation of a permit may ensue for violation of any of the rules and regulations of the Department of Health.

8. The revocation of a permit may ensue upon repeated conviction of the holder thereof of the violation of any section of the Sanitary Code relating to the adulteration of milk of any grade or designation.

Sanitary Requirements

1. Milk, condensed milk, or cream shall not be kept for sale nor stored in any stable or room used for sleeping or domestic purposes, or in any room if in communication with such stable or room, or with water-closet apartments, except when such water-closet apartments are enclosed by a vestibule and are properly ventilated to the external air.

2. Milk, condensed milk, or cream shall not be sold or stored in any room which is dark, poorly ventilated, or dirty, or in which rubbish or useless material is allowed to accumulate, or in which there are offensive odors.

3. The vessels which contain milk, condensed milk or cream, while on sale, must be so protected by suitable covers and so placed in the store that the milk, condensed milk, or cream will not become contaminated by dust, dirt or flies.

4. Cans containing milk, condensed milk, or cream shall not be allowed to stand on the sidewalk or outside of the store door.

5. Milk, condensed milk, or cream must not be transferred from cans to bottles or other vessels on the streets, at ferries or at railroad depots, except when transferred to the vessel of the purchaser at the time of delivery.

6. Cans in which milk, condensed milk, or cream is kept for sale, shall be kept either in a milk tub, properly iced, or in a clean ice-box or refrigerator in which these or similar articles of food are stored.

7. All containers in which milk, condensed milk, or cream is handled, transported, or sold, must be thoroughly cleaned and sterilized before

filling, but such cleaning shall not be done nor shall such containers be filled in any stable or in any room used for sleeping or domestic purposes, or in any room having connection with such stable or rooms, or water-closet apartment, except when such water-closet apartments are enclosed by a vestibule and are properly ventilated to the external air.

8. All dippers, measures, or other utensils used in the handling of milk, condensed milk, or cream must be kept clean while in use, and must be thoroughly cleaned with hot water and soapsuds directly after each day's use.

9. The ice-box or ice-tub in which milk, condensed milk, or cream is kept must be maintained in a thoroughly clean condition and must be scrubbed at such times as may be directed by the Department of Health.

10. The overflow pipe from the ice-box in which milk, condensed milk, or cream is kept must not be directly connected with the drain pipe or sewer, but must discharge into a properly trapped, sewer-connected, water-supplied open sink.

11. No person having a contagious disease, or caring for or coming in contact with any person having a contagious disease shall handle milk.

Labeling

Each container or receptacle used for bringing milk or cream into the City of New York, from which the said milk or cream is sold directly to the consumer, shall bear a tag stating, if shipped from a creamery, the location of the said creamery and the date of shipment; if shipped directly from a dairy, the location of the said dairy and the date of shipment.

As soon as the contents of such container or receptacle are sold, or before the said container is returned or otherwise disposed of, or leaves the possession of the dealer, the tag thereon shall be removed and kept on file in the store where such milk or cream has been sold, for a period of two months thereafter for inspection by the Department of Health.

Every wholesale dealer in the City of New York shall keep a record in his main office in the said city, which shall show the place or places from which milk or cream, delivered by him daily to retail stores in the City of New York, has been received; and the said record shall be kept for a period of two months, for inspection by the Department of Health, and shall be readily accessible to the inspectors of the said department.

Pasteurization

1. Milk, which has been subjected to the action of heat commonly known as "Pasteurization," shall not be held, kept, offered for sale, or sold and delivered in the City of New York unless the receptacle in which the same is contained is plainly labeled "Pasteurized."

2. Only such milk or cream shall be regarded as pasteurized as has been subjected to a process in which the temperature and exposure conform to one of the following:

No less than 158 degrees F. for at least 3 minutes.
No less than 155 degrees F. for at least 5 minutes.
No less than 152 degrees F. for at least 10 minutes.
No less than 148 degrees F. for at least 15 minutes.
No less than 145 degrees F. for at least 18 minutes.
No less than 140 degrees F. for at least 20 minutes.

3. The said term "Pasteurized" shall not be used in connection with the milk classified as "Grade A: Selected Milk (Pasteurized)" and "Grade B: Pasteurized," or cream obtained from such milk.

4. Milk or cream which has been heated in any degree will not be permitted to be sold in New York City unless the heating conforms with the requirements of the Department of Health for the pasteurization of milk or cream.

5. Applications for permits to pasteurize milk or cream will not be received until all forms of apparatus connected with the said pasteurization have been tested and the process approved by the Board of Health.

COUNTRY MILK INSPECTION

The present force assigned to the inspection of the source of milk supply, is composed of 33 inspectors. One supervising inspector is directly responsible for the work performed by the force which also includes six supervising inspectors who are in the field and take charge either of districts or engage in special work. For convenience of working, five districts are laid out, each containing an approximately equal number of dairies and creameries, and so arranged that railroad travel within each district is facilitated.

The routine work consists of inspecting dairies and creameries during the entire year. Once monthly all inspectors report at the Department headquarters to receive instructions, supplies and reimbursements.

The working method of an inspector detailed to routine work is as follows:

Creamery Inspection

Before beginning the inspections of dairies, the " creamery " is visited and a complete inspection made. Creamery inspection varies from the investigation of small stations composed of but two rooms where probably less than 15 cans of milk are received and shipped daily, to the large modern country plant where over 500 cans of milk, 20,000 quarts are received daily and where part of this may be condensed or separated, and the skim milk separated into casein and milk sugar. Such plants often employ 15 to 35 men at work in all departments. The average creamery however employes 3 to 5 men. Many of the creameries supplying this City with fluid milk consist of about 5 to 6 rooms on the creamery floor, each having its own particular use. First of all there is a receiving room opening on the driveway to the creamery. Milk is received, measured and examined here and then conveyed to the main milk rooms where it is prepared for shipment. Separate wash and boiler rooms are usually provided.

The inspection of a creamery is always made in the forenoon of the day when milk handling is in progress. The following is a general outline of the conditions generally inquired into and investigated by the inspector:

1. *The Delivery of Milk by Farmers.* The physical appearance, temperature and cleanliness are observed; tests as to the chemical quality are made where occasion demands the same for the purpose of detecting adulteration by the dairyman. The inspector remains on the receiving platform, examines each farmer's milk separately and either advises or warns if either is warranted. Notes are made when milk is delivered in a warm, dirty or souring condition, in order that the matter may be investigated when the repsective farm is visited.

2. *The Care of Milk in the Creamery.* The straining, cooling and handling of milk is ascertained and reported upon.

3. *The Method of Washing Milk Cans, Vats and Utensils.* This matter engages the attention of the inspector when the handling of milk has been finished, and he observes especially the cleaning and sterilizing of pumps and pipes, if such are in use.

4. *The Construction of the Creamery.* The requirements of this Department include, properly graded floors, sheathed and painted walls and ceilings of all rooms; proper drainage disposal, and adequate window light and ventilation.

5. *The Water Supply.* A sanitary survey is made with reference to the location of contaminating influences, samples are taken for

chemical and bacteriological examination, also, the adequacy of the supply is considered.

6. *The Presence of Infectious Disease.* This matter is thoroughly inquired into, particularly as to past history of typhoid fever among creamery employees. An examination is made of the files at the creamery, to ascertain if each and every patron has submitted a report certifying to the health or otherwise of those upon the dairy premises, for a period of four to eight weeks.

A score blank (Fig. No. 1) is used for reporting the general conditions and a definite numerical value is given each creamery inspected. Conditions are considered under two definite headings, viz.: *construction* and *operation*, each crediting perfect conditions with 50 per cent toward the full score. The score card is usually supplemented by special report, when adverse conditions are found.

Dairy Inspection

Subsequent to inspection at the creamery the investigation is extended to the dairy farms of the creamery's patrons. Here, as at the creamery, thorough investigation is made. Not only are adverse conditions reported, but favorable ones also, the whole being scored on a dairy report blank (Fig. 2), adopted by the Board of Health. As on the creamery blank a definite value is set on each condition and from the total a relative value is accorded each dairy. A copy of the report is left with the dairymen at each inspection. The benefit derived from this system is manifold. A competitive interest is kept alive among dairymen, a true report is left, excessive correspondence is avoided and complete and proper inspection by the inspector is assured.

The dairy score card again does not completely cover all cases. In many instances, especially insanitary conditions are found to exist, conditions which may not affect the score sufficiently to serve as a danger signal and in such instance special report is made by the inspector.

The information recorded is as follows:

1. *Complete Data as to Location and Ownership.* This is done in order that the report may be properly designated in the office.

2. *The Water Supply.* Its apparent purity according to a sanitary survey, the sampling of suspicious sources for chemical and bacteriological examinations; locations of privies, cesspools and manure piles, are considered.

3. *The Presence of Infectious Disease.* Inquiry is made as to the health or otherwise of all persons on the farm, also previous history of typhoid is ascertained.

SECTION IV—DISINFECTION AND DISINFECTANTS

CHAPTER I

INFECTION AND DISINFECTION

DISINFECTION is the destruction of the infective power of infectious material; or, in other words, disinfection is the destruction of the agents of infection.

An infectious material is one contaminated with germs of infection.

The germs of infection are organic micro-organisms, vegetable and animal—protozoa and bacteria.

The germs of infection once being lodged within the body cause certain reactions producing specific pathological changes and a variety of groups of symptoms which we know by the specific names of infectious diseases, e.g., typhoid, typhus, etc.

Among the infectious diseases known to be due to specific germs are the following: Typhoid, Typhus, Relapsing Fevers, Cholera, Diphtheria, Croup, Tuberculosis, Pneumonia, Malaria, Yellow Fever, Erysipelas, Septicœmia, Anthrax, Tetanus, Gonorrhea, Syphilis, etc.; and among the infectious diseases the germs of which

have not as yet been discovered are the following: Scarlet Fever, Measles, Smallpox, Varicella, etc.

The part of the body and the organs in which the germs first find their entrance or which they specifically attack vary with each disease; thus the mucous membranes, skin, internal organs, secretions and excretions are severally either portals of infection, or the places where the infection shows itself the most.

The agents carrying the germs of infection from one person to the other may be the infected persons themselves, or anything which has come in contact with their bodies and its secretions and excretions; thus the air, room, furniture, vessels, clothing, food, and drink, also insects and vermin, may all be carriers of infection.

Sterilization is the absolute destruction of *all* organic life, whether infectious or not; it is therefore *more* than disinfection which destroys the germs of infection alone.

A **disinfectant** is an agent which destroys germs of infection.

A **germicide** is the same: an agent destroying germs.

An **insecticide** is an agent capable of destroying insects; it is not necessarily a disinfectant, nor is a disinfectant necessarily an insecticide.

An **antiseptic** is a substance which inhibits and stops the growth of the bacteria of putrefaction and decomposition. A disinfectant is therefore an antiseptic, but an antiseptic may not be a disinfectant.

A **deodorant** is a substance which neutralizes or destroys the unpleasant odors arising from matter undergoing putrefaction. A deodorant is not necessarily a disinfectant, nor is every disinfectant a deodorant.

The ideal disinfectant is one which, while capable of destroying the germs of disease, does not injure the bodies and material upon which the germs may be found; it must also be penetrating, harmless in handling, inexpensive, and reliable. The ideal disinfectant has not as yet been discovered.

For successful scientific disinfection it is necessary to know: (1) the nature of the specific germs of the disease; (2) the methods and agents of its spread and infection; (3) the places where the germs are most likely to be found; (4) the action of each disinfectant upon the germs; and (5) the best methods of applying the disinfectant to the materials infected with germs of disease.

Disinfection is not a routine, uniform, unscientific process; a disinfector must be conversant with the basic principles of disinfection, must make a thorough study of the scientific part of the subject, and moreover must be thoroughly imbued with the importance of his work, upon which the checking of the further spread of disease depends.

CHAPTER II

PHYSICAL DISINFECTANTS

THE physical disinfectants are sunlight, desiccation, and heat.

Sunlight is a good disinfectant provided the infected material or germs are directly exposed to the rays of the sun. Bacteria are killed within a short time, but spores need a long time, and some of them resist the action of the sun for an indefinite period. The disadvantages of sunlight as a disinfectant are its superficial action, its variability and uncertainty, and its slow action upon most germs of infection. Sunlight is a good adjunct to other methods of disinfection; it is most valuable in tuberculosis, and should be used wherever possible in conjunction with other physical or chemical methods of disinfection.

Desiccation is a good means of disinfection, but can be applied only to very few objects; all bacteria need moisture for their existence and multiplication, hence absolute dryness acts as a good germicide. Meat and fish, certain cereals, and also fruit, when dried become at the same time disinfected.

Heat is the best, most valuable, all-pervading, most available, and cheapest disinfectant. The various ways in which heat may be used for disinfection are burning, dry heat, boiling, and steam.

Burning is of course the best disinfectant, but it not only destroys the germs in the infected materials, but the materials themselves; its application is therefore limited to articles of little or no value, and to rags, rubbish, and refuse.

Dry Heat. All life is destroyed when exposed to a dry heat of 150° C. for one hour, although most of the bacteria of infection are killed at a lower temperature and in shorter time. Dry heat is a good disinfectant for objects that can stand the heat without injury, but most objects, and especially textile fabrics, are injured by it.

Boiling. Perhaps the best and most valuable disinfectant in existence is boiling, because it is always at command, is applicable to most materials and objects, is an absolutely safe sterilizer and disinfectant, and needs very little if any preparation and apparatus for its use. One half-hour of boiling will destroy all life; and most bacteria can be killed at even a lower temperature. Subjection to a temperature of only 70° C. for half an hour suffices to kill the germs of cholera, tuberculosis, diphtheria, plague, etc. Boiling is especially applicable to textile fabrics and small objects, and can readily be done in the house where the infection exists, thus obviating the necessity of conveying the infected objects elsewhere, and perhaps for some distance, to be disinfected.

Steam. Of all the physical disinfectants steam is the most valuable because it is very penetrating, reliable, and rapid; it kills all bacteria at once and all spores in a few minutes, and besides is applicable to a great number and many kinds of materials and objects.

Steam is especially valuable for the disinfection of clothing, bedding, carpets, textile fabrics, mattresses, etc. Steam can be used in a small way, as well as in very large plants. The well-known Arnold sterilizers, used for the sterilization of milk, etc., afford an example of the use of steam in a small apparatus; while municipal authorities usually construct very large steam disinfecting plants. A steam disinfector is made of steel or of wrought iron, is usually cylindrical in shape, and is covered with felt, asbestos, etc. The disinfector has doors on one or both ends, and is fitted inside with rails upon which a specially constructed car can be slid in through one door and out through the other. The car is divided into several compartments in which the infected articles are placed; when thus loaded it is run into the disinfector. The steam disinfectors may be fitted with thermometers, vacuum-formers, steam-jackets, etc.

CHAPTER III

GASEOUS CHEMICAL DISINFECTANTS

PHYSICAL disinfectants, however valuable and effiicient, cannot be employed in many places and for many materials infected with disease germs, and therefore chemicals have been sought to be used wherever physical disinfectants can not for one or more reasons be employed. Chemicals are used as disinfectants either in gaseous form or in solutions; the gaseous kinds are of especial value on account of their penetrating qualities, and are employed for the disinfection of rooms, holds of ships, etc. There are practically but two chemicals which are used in gaseous disinfection; and these are sulphur dioxide and formaldehyde.

Sulphur Dioxide. Sulphur dioxide (SO_2) is a good surface disinfectant, and is very destructive to all animal life; it is one of the best insecticides we have, but its germicidal qualities are rather weak, it does not kill spores, and it penetrates only superficially. The main disadvantages of sulphur dioxide as a disinfectant are: (1) that it weakens textile fabrics; (2) blackens and bleaches all vegetable coloring-matter; (3) tarnishes metal; and (4) is very injurious and dangerous to those handling it.

There are several methods of employing sulphur in

the disinfection of rooms and objects, e.g., the pot, candle, liquid, and furnace methods.

In the pot methods crude sulphur, preferably ground, is used; it is placed in an iron pot and ignited by the aid of alcohol, and in the burning evolves the sulphur dioxide gas. About 5 pounds of sulphur are to be used for every 1000 cubic feet of space. As moisture plays a very important part in developing the disinfectant properties of sulphur dioxide, the anhydrous gas being inactive as a disinfectant, it is advisable to place the pot in a large pan filled with water, so that the evaporated water may render the gas active. For the purpose of destroying all insects in a room an exposure to the gas of about two hours is necessary, while for the destruction of bacteria an exposure of at least 15 to 16 hours is required.

In the application of disinfection with sulphur dioxide, as with any other gas, it must not be forgotten that gases very readily escape through the many apertures, cracks, and openings in the room and through the slits near doors and windows; and in order to confine the gas in the room it is absolutely necessary to close hermetically all such apertures, cracks, etc., before generating the gaseous disinfectant. The closing of the openings, etc., is done by the pasting over these, strips of gummed paper, an important procedure which must not be overlooked, and which must be carried out in a conscientious manner.

When sulphur is used in candle form the expense is considerably increased without any additional efficiency. When a solution of sulphurous acid is employed, exposure of the liquid to the air suffices to

disengage the sulphur dioxide necessary for disinfection. The quantity of the solution needed is double that of the crude drug, i.e., 10 pounds for every 1000 cubic feet of room space.

Formaldehyde. At present the tendency is to employ formaldehyde gas instead of the sulphur so popular some time ago. The advantages of formaldehyde over sulphur are: (1) its non-poisonous nature; (2) that it is a very good germicide; (3) has no injurious effect upon fabrics and objects; (4) does not change colors; and (5) can be used for the disinfection of rooms with the richest hangings, bric-a-brac, etc., without danger to these. Formaldehyde is evolved either from paraform or from the liquid formalin; formerly it was also obtained by the action of wood-alcohol vapor upon red-hot platinum.

Formaldehyde gas has not very great penetrating power; it is not an insecticide, but kills bacteria in a very short time, and spores in an hour or two.

Paraform (polymerized formaldehyde; trioxymethylene) is sold in pastiles or in powder form, and when heated reverts again to formaldehyde; it must not burn, for no gas is evolved when the heating reaches the stage of burning. The lamps used for disinfection with paraform are very simple in construction, but as the evolution of the gas is very uncertain, this method is used only for small places, and it demands 2 ounces of paraform for every 1000 cubic feet of space, with an exposure of 12 hours. Formaldehyde is also used in the form of the liquid formalin either by spraying and sprinkling the objects to be disinfected with the liquid, and then placing them in a tightly covered box, so

that they are disinfected by the evolution of the gas, or by wetting sheets with a formalin solution and letting them hang in the room to be disinfected.

The method most frequently employed is to generate the formaldehyde in generators, retorts, and in the so-called autoclaves, and then to force it through apertures into the room.

Of the other gaseous disinfectants used hydrocyanic acid and chlorine may be mentioned, although they are rarely used because of their irritating and poisonous character.

Hydrocyanic acid is frequently used as an insecticide in ships, mills, and greenhouses, but its germicidal power is weak.

Chlorine is a good germicide, but is very irritating, poisonous, and dangerous to handle; it is evolved by the decomposition of chlorinated lime with sulphuric acid. Chlorine gas is very injurious to objects, materials, and colors, and its use is therefore very limited.

CHAPTER IV

SOLUTIONS OF CHEMICALS USED AS DISINFECTANTS

SOLUTION of chemicals, in order to be effective, must be used generously, in concentrated form, for a prolonged time and, if possible, warm or hot. The strength of the solution must depend upon the work to be performed and the materials used. The method of applying the solution differs. It may consist in immersing and soaking the infected object in the solution; or the solution may be applied as a wash to surfaces, or used in the form of sprays, atomizers, etc. The most important solutions of chemicals and the ones most frequently employed are those of carbolic acid and bichloride of mercury.

Carbolic Acid. In the strength of 1:15,000 carbolic acid prevents decomposition; a strength of 1:1000 is needed for the destruction of baçteria, and a 3 to 5 per cent solution for the destruction of spores. Carbolic acid is used, as a rule, in 2 to 5 per cent solutions, and is a very good disinfectant for washing floors, walls, ceilings, woodwork, small objects, etc. The cresols, creolin, lysol, and other solutions of the cresols are more germicidal than carbolic acid, and are sometimes used for the same purposes.

Bichloride of Mercury (Corrosive Sublimate) is a potent poison and a powerful germicide; in solutions of 1:15,000 it stops decomposition; in solutions of 1:2000 it kills bacteria in 2 hours; and in a strength of 1:500 it acts very quickly as a germicide for all bacteria, and even for spores. Corrosive sublimate dissolves in 16 parts of cold, and 3 parts of boiling water, but for disinfecting purposes it should be colored so that it may not be inadvertently used for other purposes, as the normal solutions are colorless and may accidentally be used internally. The action of the bichloride is increased by heat.

Formalin is a 40 per cent solution of formaldehyde gas, and its uses and methods of employment have been considered before.

Potassium Permanganate is a good germicide, and weak solutions of it are sufficient to kill some bacteria, but the objections against its use are that solutions of potassium permanganate become inert and decompose on coming in contact with any organic matter. Furthermore, the chemical would be too expensive for disinfecting purposes.

Ferrous Sulphate (Copperas) was formerly used very extensively for disinfecting purposes, but is not so used at present, owing to the fact that it has been learned that the germicidal power of this material is very slight, and that its value depends mostly upon its deodorizing power, for which reason it is used on excreta, in privy vaults, etc.

Lime. When carbonate of lime is calcined the product is common lime, which, upon being mixed with water, produces slaked lime; when to the latter con-

siderable water is added, the product is milk-of-lime and also whitewash. Whitewash is often used to disinfect walls and ceilings of cellars as well as of rooms; milk of lime is used to disinfect excreta in privy vaults, school-sinks, etc. Whenever lime is used for disinfecting excreta it should be used generously, and should be thoroughly mixed with the material to be disinfected.

CHAPTER V

DISINFECTION OF ROOMS AND INFECTED OBJECTS

PRACTICAL disinfection is not a routine, uniform, and thoughtless process, but demands the detailed, conscientious application of scientific data gained by research and laboratory experiment. Disinfection to be thorough and successful cannot be applied to all objects, materials, and diseases in like manner, but must be adjusted to the needs of every case, and must be performed conscientiously. Placing a sulphur candle in a room, spilling a quart of carbolic acid or a couple of pounds of chlorinated lime upon the floors or objects, may be regarded as disinfection by laymen, but in municipal disinfection the disinfector must be thoroughly versed in the science of disinfection and be prepared to apply its dictates to practice.

Rooms. In the disinfection of rooms the disinfectant used varies with the part of the room as well as with the character of the room. When a gaseous disinfectant is to be used sulphur dioxide or formaldehyde is employed, with the tendency lately to replace the former by the latter. Wherever there are delicate furnishings, tapestries, etc., sulphur cannot be used on account of its destructive character; when sulphur is employed it is, as a rule, in the poorer class of tenement houses where there is very little of value to be

injured by the gas, and where the sulphur is of additional value as an insecticide. Whenever gaseous disinfectants are used the principal work of the disinfector is in the closing up of the cracks, apertures, holes, and all openings from the room to the outer air, as otherwise the gaseous disinfectant will escape. The closing up of the open spaces is accomplished usually by means of gummed-paper strips, which are obtainable in rolls and need only to be moistened and applied to the cracks, etc. Openings into chimneys, ventilators, transoms, and the like, must not be overlooked by the disinfector. After the openings have been closed up the disinfectant is applied and the disinfector quickly leaves the room, being careful to close the door behind him and to paste gummed paper over the door-cracks. The room must be left closed for at least 12, or better, for 24 hours, when it should be opened and well-aired.

Walls and ceilings of rooms should be disinfected by scrubbing with a solution of corrosive sublimate or carbolic acid; and in cases of tuberculosis and wherever there is fear of infection adhering to the walls and ceilings, all paper, kalsomine, or paint should be scraped off and new paper, kalsomine, or paint applied.

Metal furniture should first be scrubbed and washed with hot soap-suds, and then a solution of formalin, carbolic acid, or bichloride applied to the surfaces and cracks.

Wooden bedsteads should be washed with a disinfecting solution and subjected to a gaseous disinfectant in order that all cracks and openings be penetrated and all insects be destroyed.

Bedding, mattresses, pillows, quilts, etc., should be packed in clean sheets moistened with a 5 per cent solution of formalin, and then carted away to be thoroughly disinfected by steam in a special apparatus.

Sheets, small linen and cotton objects, tablecloths, etc., should be soaked in a carbolic-acid solution and then boiled.

Rubbbish, rags, and objects of little value found in an infected room are best burned.

Glassware and chinaware should either be boiled or subjected to dry heat.

Carpets should first be subjected to a gaseous disinfectant, and then be wrapped in sheets wetted with formalin solution and sent to be steamed. Spots and stains in carpets should be thoroughly washed before being steamed, as the latter fixes the stains.

Woolen goods and wool are injured by being steamed, and hence may be best disinfected by formalin solutions or by formaldehyde gas.

Books are very difficult to disinfect, especially such books as were handled by the patient, on account of the difficulty of getting the disinfectant to act on every page of the book. The only way to disinfect books is to hang them up so that the leaves are all open, and then to subject them to the action of formaldehyde gas for 12 hours. Another method sometimes employed is to sprinkle a 5 per cent solution of formalin on every other page of the book; but this is rather a slow process.

Stables need careful and thorough disinfection. All manure, hay, feed, etc., should be collected, soaked in oil, and burned. The walls, ceilings, and floors should then be washed with a strong disinfecting solution

applied with a hose; all cracks are to be cleaned carefully and washed. The solution to be used is preferably lysol, creolin, or carbolic acid. After this the whole premises should be fumigated with sulphur or formaldehyde, and then the stable left open for a week to be aired and dried, after which all surfaces should be freshly and thickly kalsomined.

Food cannot be disinfected very well unless it can be subjected to boiling. When this is impossible it should be burned.

Cadavers of infected persons ought to be cremated, but as this is not always practicable, the next best way is to wash properly the surface of the body with a formalin or other disinfecting solution, and then to have the body embalmed, thus disinfecting it internally and externally.

Disinfectors, coming often as they do in contact with infected materials and persons, should know how to disinfect their own *persons and clothing*. So far as clothing is concerned the rule should be that those handling infected materials have a special uniform which is cleaned and disinfected after the day's work is done. The hands should receive careful attention, as otherwise the disinfector may carry infection to his home. The best method of disinfecting the hands is to wash thoroughly and scrub them for 5 minutes with green soap, brush, and water, then immerse first for one minute in alcohol, and then in a hot 1:1000 bichloride solution. The nails should be carefully scrubbed and cleaned.

PART THIRD

SANITARY INSPECTION

CHAPTER I

SANITATION AS A PROFESSION

FIFTY years ago there was no such profession as Sanitation. There were a number of persons interested in public-health questions and sanitary problems, but these were the philanthropists and public-spirited men, the pioneers of sanitary reform who strove to better the condition of their fellowmen, to lower the death rate of the community, and to inculcate into the minds of the people the wise saying of Franklin, that "Public health is public wealth."

Thanks to the unselfish devotion and strenuous efforts of those pioneers, great strides were made in the sanitary progress of the nation; vast reforms were undertaken and accomplished; the health of communities was improved; the death-rates of city populations cut in half; and permanent sanitary organizations founded by the establishment of various boards of health in villages, towns, and cities.

The organization of the various sanitary authorities in so many places necessitated the employment of a number of sanitary officers; this number has steadily increased until at present there are several thousand men in the United States engaged in the various departments connected with sanitary work.

At first, when the sanitary work was unorganized and crude, the men engaged in the pursuance of the various investigations were mostly volunteers, principally medical men.

The incomparable, painstaking, thoroughly scientific reports left by some of these volunteers are monuments to their efficiency; *vide* the Report of the Quarantine Convention of 1859, the Report on the Sanitary Condition of New York of the Council of Hygiene in 1866, and others.

With the enlargement and widening of the sanitary field, however, volunteer work became inadequate, and a number of men, mostly physicians, were appointed to continue the work so well begun by the volunteers.

With time and progress the sanitary field has become differentiated and specialized, until, at present, we have the various branches of sanitary work, each with its special inspectors, such as Health, Factory, Sanitary, Building, Plumbing, Offensive-trades, Contagious-disease, Meat, Milk, Fruit, Tenement-house, etc., Inspectors, all embraced in the great and noble profession of Sanitation.

But as the medicine of to-day differs from the medicine of the middle of the last century, and as the educational standard of the physician of the twentieth century is above that of the nineteenth century, so

is the sanitation of to-day different from that of 50 years ago; and the educational standard of the sanitary inspector of to-day is different (or it ought to be) from the standard of the sanitary officers of years ago.

Unfortunately, the sanitary profession of to-day is not as yet what it ought to be, not being filled with the best elements of the medical and engineering professions which are the proper professions for sanitary work. The reasons for this shortcoming are the following:

(1) the political selection of sanitary employees;
(2) inadequate compensation;
(3) insufficient education;
(4) absence of organization among the sanitary employees.

Let us examine these causes more thoroughly.

Political Selection of Sanitary Officers. Dr. Chas. V. Chapin, in his book on "Municipal Sanitation in the United States," says: "Unfortunately most appointees to official sanitary positions in the United States are entirely untrained for the duties they are to perform. To exhibit some degree of natural ability is all that is asked, and often this is not required, the sole qualification of the appointee being his political service to the party which has the appointing power, . . . the successful candidate needs no other recommendation than that of 'influential friends.'"

Dr. Wende, of Buffalo, also deplores the political selection of sanitary officers. (*Chicago Medical Record*, April, 1901.)

Of course, while conditions remain as they are; while the sanitary inspector is in danger of losing his place

by the frequent political party upheavals, while the tenure of office is insecure; and while the fitness of the candidate is political instead of scientific, educated, intelligent, and trained men will neither seek nor get sanitary positions.

However, there is already noticeable in many cities a tendency toward reform in this direction; and thanks to the various civil service laws, as well as to public opinion, there are fewer changes made in health and sanitary departments than before, and sanitary officers are left undisturbed when their fitness for their work has been proven. There is, therefore, a tendency to establish a permanent tenure of office during good behavior, and the position of the sanitary inspector begins to be more and more secure.

A permanent tenure of office should also imply a pension for length of service and disability; and in some places, notably so in New York City, quite a liberal pension provision is, in fact, embodied in the Charter of 1901.

Let us hope, too, that the time is not distant when the following desideratum of Dr. Wende in the article quoted will be fulfilled, viz.: "Selection of municipal health officers for fitness, with secure tenure of office and proper compensation. The municipalities should not be exposed to unnecessary risks by politics." This brings us to the next question of

Proper Compensation. The work of the sanitary officer is manifold, arduous, difficult, and fraught with many dangers to health and life. If there are any sinecures in the public employment, they are not in the health and sanitary departments. There is no class of

municipal employees whose work is so constant, exacting, difficult, irregular, dangerous, and important, as is that of the sanitary inspectors. The sanitary officer has no 8-hour work-day, with a Saturday half-holiday; he is *always* on duty. Day and night he must be at his post, and when going to bed he is not sure that he will not be called out for some special sanitary work.

He is resposible for the condition of his district; any citizen may come up and find fault with his work; the chronic kicker who finds fault with some intangible nuisance demands that his theories be accepted by the inspector; the "one of the tenants," who is afraid to sign his name to the complaint, threatens to go to the Mayor if his complaint is not attended to at once. Apart from all these, the inspector in the performance of his duties directly endangers his health and life, for he has to climb rickety stairways, go down into cellars full of water and mud, inhale the noxious fumes of open drains and sewers, and come in contact with diphtheria, scarlet fever, typhoid, and other infectious diseases from which the ordinary citizen flees in horror.

If we add to the above the fact that a sanitary officer must possess certain intellectual and educational qualifications, as will be seen later, we should at least expect to find the compensation of the officer adequate to recompense him for his arduous and dangerous work. But on the contrary we find the facts are that, so far from his receiving a high salary, he gets a smaller salary than untrained and uneducated officers in other departments of the municipality. In New York City a janitor of a public school, a messenger in some department, or some other such employee,

receives more than the physician or engineer employed in the Health Department.

According to Dr. Chapin, the salaries of sanitary inspectors in the United States range from $600 per annum in Rochester, Cincinnati, Charleston, and Hartford, to $1200 in New York. The average salary in smaller cities is $900, and in larger $1000.

Now, there is no doubt that these salaries are inadequate for the work performed, and for the qualified men who are required for sanitary positions. Most sanitary positions are filled by civil and sanitary engineers and physicians, and it is evident that such men cannot be satisfied with the above salaries. Add to this also the fact that in no position are advancement and increase of salary less to be expected than in municipal positions. When a man works for a private corporation he expects a rise in position and influence proportionate to the years of employment, and the employer need ask no one for permission to raise the salary of a trusted employee. In municipal positions it is difficult to secure an advancement; and every increase of salary raises such a howl from the organs of the party not in power that the heads of departments prefer to let efficient sanitary workers of many years remain at a miserable salary rather than risk harsh criticism from unfriendly organs.

In my opinion, inspectors in large cities should begin with a salary of $1000 or $1200 per annum, and each year should be raised by a certain sum, say $50-$60, so that after 15 or 20 years the salary of the sanitary inspector will reach an amount in proportion to his value and experience.

Inadequate Education. In England the public-health laws require that a sanitary inspector shall have a certificate from one of the several sanitary institutes giving diplomas in sanitation, after a course of study and thorough examination. Here in the United States, we have no such special institutes, and no educational requirement is made of the candidate except a civil-service examination, which is, at best, insufficient to show the qualification of the candidate. It is true, some medical and other colleges have lately established courses in sanitary science, but the teaching is as yet very rudimentary, and the students are not those who usually seek sanitary positions.

Absence of Organization and Esprit de Corps among Sanitary Officers. In England there are several powerful sanitary organizations, such as the Sanitary Inspectors, the Health Officers' Association, the National Health Workers, etc., and almost every sanitary officer of every hamlet, village, or city, belongs to one or other of these organizations. There are also quite a number of very able and influential sanitary monthly and weekly papers devoted solely to sanitation, and read by inspectors. We have nothing of the kind in the United States. There are only one or two monthly journals, hardly ever read by sanitary officers, and there is no organization whatever among the several thousand employees of the various health departments throughout the States.

The evils enumerated and discussed in detail must be eradicated before sanitation, as a profession, will attain a higher place and receive the recognition to which it is entitled.

The objects sought should be:

The selection of sanitary officers for fitness only, after passing a certain educational test; a permanent tenure of office; a substantial salary at the beginning, increasing every year, with a pension after 20 years; also, a thorough organization of all workers in sanitation, with news organs and proper sanitary publications of their own, meetings, conventions, etc.

CHAPTER II

QUALIFICATIONS FOR AND ART OF INSPECTION

Qualifications. He who intends to devote himself to the profession of sanitation must be possessed of certain qualifications. In the first place, he should be blessed with a robust, strong constitution, and perfect health, otherwise he will not be able to stand the wear and tear incident to the profession. He should have perfect eyesight, hearing, and sense of smell. He should have at least a high-school education; should know something of geology, physics, chemistry, mathematics, mechanics, physiology, and the allied sciences, and should be able to draw. He should have made a thorough study of sanitation, both theoretical and practical; should understand thoroughly the principles of ventilation, drainage, plumbing, etc., besides knowing enough of practical building construction, etc., that he may not be hoodwinked by builders or plumbers. The inspector should also be fully conversant with all the State and local laws concerning his specialty, and possess the intelligence to pursue the investigations which from time to time may be entrusted to him. The inspector should, of course, have that command of the language which will enable him to make a creditable report to his superiors. He should be sober, industrious,

observant, vigilant, conscientious, honest, and thoroughly imbued with the noble spirit of his profession. He should always bear in mind that he is the physician of the community; that the health and life of the people entrusted to his care depend upon the good work he is doing in his field, and that every effort of his to abate a public nuisance lowers the death-rate in his district and conduces to the health of his fellowmen.

The Art of Inspection. Sanitary inspection means the application of the teachings of the science of sanitation to practice, and as such, inspection becomes an art in which skill and experience count highly. Any one can inspect a house, and anybody may examine a public nuisance, but not every one can find all the defects in the house, or discover the cause of the nuisance; to do this it requires not only theoretical knowledge, but skill and experience as well. The physician just from college may know more of anatomy, etc., than the old practitioner; but who will not pity the poor unfortunate who entrusts the diagnosis of his malady to the youngster just from the college benches. So it is with the sanitary inspector. The probationer may and should know much regarding the theory of sanitation, but he will make the mistake of his life if he thinks he knows it all; and he may find himself rather humiliated when he fails to find defects which an ignorant plumber is able to point out to him in a moment. In sanitation, as in any other profession, experience and practice are required before the inspector can be depended upon to know thoroughly and understand his subject, and be able to make practical application of his theoretical knowledge.

One of the principal points the inspector has to learn is to distinguish between when he is expected to be an expert, and when he is nothing more than a witness. The inspector is the ears and eyes of the sanitary authority; and when sent out to inspect a building, etc. he must state FACTS ONLY, and nothing more, and let his superiors draw the conclusions, etc. When, however, he is empowered to investigate the causes of a public nuisance, he becomes an expert, and here he must use sound judgment, and be prepared to support his conclusions with his theoretical knowledge and practical experience.

CHAPTER III

TENEMENT-HOUSE INSPECTION

THE defects in tenement houses are of three kinds:

(1) Defects of construction.

(2) Defects of maintenance.

(3) Defects of condition.

For the first the real-estate men and builders are responsible.

The responsibility for the second rests upon the owner of the house, or his agent and housekeeper.

The fault for the third class of defects lies solely with the tenant and occupant.

A badly-constructed house may be kept in good sanitary order if the owner keeps it in good repair, and the tenants maintain it in good condition; on the other hand, the best-constructed house will be in ruins in a short time if neglected by the landlord and abused by the occupants.

So it is also between the landlord and tenant. No matter how clean the people of the house may be, the house will become a pest-hole if the landlord allows the roof to leak, the tank to fill with dirt, the sewer to be obstructed, the walls and ceilings to remain encrusted with filth. On the other hand, no matter how much the owner may spend on maintaining his house in good

repair, and on cleaning and beautifying it, the house is bound to become a menace to health and a breeding-place for bacteria, if the class of tenants is such that cleanliness is unknown among them, if they persist in tearing down walls, piling refuse everywhere, making holes in pipes, abusing fixtures, etc.

These considerations have to be kept in view in tenement-house inspection, in order to know how to inspect and whom to make responsible for the defects found and the conditions discovered detrimental to health.

An inspection of tenement houses as to construction and defects in them, also as to light and ventilation, should be made by the building, light, and ventilation inspectors during and after construction of the building. The sanitary or tenement-house inspector should attend to the inspection of the defects of repair and maintenance of the house, while the inspection of the condition in which the house is kept by the tenants ought to be entrusted to the sanitary police.

The time an inspection of a tenement house ought to require depends upon the kind of inspection made, as well as upon the number of stories and apartments the house contains. To peep into the cellar, glance at the privy accommodations, look up into the halls, and take in the view of the yard, may mean an inspection; and, unfortunately, many an inspector is compelled to do no more from stress of work and the enormous size of his district. But this is not an inspection, and need not take more than a few minutes of his time.

On the other hand, a thorough inspection of a house, an examination of the construction, ventilation, light, plumbing, drainage, and condition of a five-story

tenement house, requires not only skill, experience, and patience, but also *time*, and can hardly be done in less than several hours. Such an inspection as covered in the "Notes of a Complete Inspection of a Tenement House," in the following chapters, must take quite a few hours; but, once done, may be put on record, and will facilitate subsequent inspections of the same house. Therefore, every tenement house ought to be inspected in such a thorough manner at least once a year, and the results of inspection carefully recorded, so that the subsequent inspections need not require as much time. This is one reason why an inspector should be kept for a long time in the same district; for, after a certain time, he becomes intimately acquainted with every house in his district, and will be better able to take care of his district and watch for defects, violations of the law, and public nuisances, than the inspector recently placed in a district.

The mode of inspecting a tenement house may differ somewhat with every inspector. Some begin in the cellar and work up to the roof; others begin at the roof and inspect while going down to the cellar. The best way would be, in my opinion, to combine both methods and begin in the cellar, examining and noting all defects while going up to the roof, and then go over the same field and verify, correct, and complete the inspection as one goes down again.

Here I may add one thing which the inspector must always bear in mind, and that is: to mind his own business and *never*, NEVER talk to the owner, housekeeper, or tenants about his inspection, his work, what he finds, and what he is going to report. The

inexperienced inspector may feel benevolently disposed to his fellowman, and may not be able to withstand the wiles of the ubiquitous landlord, who will want to know the report and finding of the inspector; but be assured that his every innocent remark may find its way into higher quarters, and he may find himself a victim of his own loquacity. The inspector is sent to investigate and make his report to his chief; and, until he makes such report, all he sees and discovers must not be talked about or divulged to any one; and it is a wise policy to inform gently but firmly the too-insistent owner, or others, that the inspector must first make his report to his superior, and that in due time the owner will know what the inspector has to report.

Another matter of importance to be kept in mind during inspection of tenement houses, as well as other inspections, is neither to be too lenient nor too strict, neither to fear nor favor the owner of the house, but always to give facts as they are and nothing more, no matter how the inspector may be treated by the caretaker or owner of the house. Some owners or agents of houses, when meeting an inspector on duty in their houses, are apt to become indignant, insolent, and overbearing; nevertheless the inspector should not be influenced by this in submitting his report. Above all, the inspector must remember his duty, his oath, and his office as guardian of the public health, and be above petty, selfish, and small considerations.

CHAPTER IV

CIVIL SERVICE EXAMINATIONS

A CIVIL-SERVICE examination is not the best test of the fitness of a candidate; but in the absence of any better, and in the absence of proper schools for sanitary training, such examinations show, at least, whether a candidate has any knowledge of the subject in which he is examined.

The questions put in the various sanitary examinations, are as a rule, fair, and not very difficult for any one with a knowledge of sanitation to answer. A very important part of the examination is that containing the questions bearing on the local laws of the department in which the examination is held, and the candidate must make a thorough study of these laws.

From 10 to 30 questions are given to the applicant, who has from 5 to 6 hours in which to answer them. Among so many questions there are a number which are easy to answer, a number somewhat more difficult, and a few to answer which may not be possible to the candidate. The best procedure is to begin with the easiest questions first; answer them as thoroughly as possible, then to proceed to the more difficult and leave the most difficult for the last; otherwise, if the applicant begins with the hard questions first, he is

discouraged, loses the time in which he might be answering the easier questions, and loses all spirit and hope, so that he is unfit to give good answers to questions which at first would have been very easy. The answers and explanations must be clear, short, and to the point. The candidate is not expected to write a treatise on each subject, but merely to give a clear and readable opinion, so that the examiner may judge how much the applicant knows of the subject. Legible handwriting is a great advantage in civil-service examinations, as the examiners are but human, and often in despair of deciphering the writing of an able paper, may give up the task and leave the candidate with a low percentage.

CIVIL-SERVICE EXAMINATION QUESTIONS

The questions here published have been given by the New York State and Municipal Civil Service Commissions to candidates for the various sanitary positions. A study of these questions will prove beneficial to candidates and students in general.

FOOD INSPECTOR

Special

1. What are the duties of a Food Inspector?

2. To what extent should a Food Inspector acquaint himself with (*a*) the sources of supply; (*b*) the seasons at which different kinds of food are offered in the markets; (*c*) the points at which these supplies are delivered in the city; (*d*) the distribution of such supplies to the different places of sale?

3. How should an ice-box be connected with the sewer? Draw a plan showing pipes and connections.

4. You are sent as an Inspector to visit five different places where food is offered for sale. In some of these places you find the food

not fit for use. In some you find bad arrangements. Assuming such facts as you please, write a report to the Chief Inspector giving the results of your inspection.

Division I.—Meat and Poultry

5. State the common terms applied to diseased or unfit veal, mutton, pork, and poultry, and define precisely each term.

6. (*a*) What is pleuro-pneumonia and what animals are subject to that disease? (*b*) What are the indications of this disease in animals before and after slaughtering?

7. What is the "Kosher" method of slaughtering?

8. What are the common diseases (*a*) of hogs; (*b*) of poultry? How are they to be detected? Which of them makes the animal unfit for food?

9. How can the existence of fever in an animal, at the time of slaughtering, be detected in the dressed meat? How is the temperature of a living animal ascertained?

10, 11, 12. Give the name and describe the condition of each specimen shown you. (The candidate should make notes, at the time of the inspection, and afterward write description in full, arranging his answers to correspond with the number of each specimen.)

Division II.—Fish

5. What kinds of fish are found in our markets and at what time of year is each kind offered for sale?

6. Name the principal sources of supply of each kind you have mentioned in your answer to question 5.

7. In inspecting fish, state precisely to what points you would direct your attention and what indications would, in your opinion, show that the fish were unfit for sale. Answer this question fully.

8. Answer the question put in No. 7 with reference both to cooked and uncooked shell fish.

9. How would you test canned fish and oysters without opening the cans?

10, 11, 12. Give the name and describe the condition of each specimen shown you.

Division III.—Milk

5. Give the terms in common use applied to milk in its different forms and stages, and describe precisely the meaning of each term. State which of these, in your opinion, makes the milk unfit for sale,

and state what test you would make of a specimen submitted to you to determine its character.

6. What is a lactometer? Describe it and state how it is used.

7. How would you test canned condensed milk without opening the can?

8. State what, in your opinion, are the necessary arrangements, conditions, and appliances where milk is kept on sale. What is the proper temperature at which to keep milk in places of sale?

9. Name the most common adulterants of milk; state for what purpose each is used. How you would try to detect it, and in what way, if at all, each is harmful.

10, 11, 12. Examine each specimen shown you and give your full opinion of it.

Division IV.—Fruits and Vegetables

5. Describe "baked" banana, "speck" pine, "baked" orange; what causes these imperfections and how they are detected?

6. What conditions, in your opinion, would make potatoes, cabbages, and tomatoes unfit for sale, and how would you determine these conditions?

7. State, fully, the proper arrangements and appliances of shops where fruit and vegetables are on sale.

8. Describe fully your method of judging cocoanuts.

9. How do you test canned goods without opening? State fully.

10 and 11. State the principal sources of supply and the seasons of sale of the staple fruits and vegetables in New York City.

12. Is there any special care to be taken in inspecting fruit offered for sale on the street? If so, what?

13. How do you test melons without cutting? What do you consider the practical value of the test?

14. What are "soaked" canned goods?

Arithmetic

1. Add. 2. Substract. 3. Multiply. 4. Divide.

Experience

This paper consists of seven questions pertaining to what the education of the candidate consisted of, and experience.

N. B.—All candidates must answer questions 1 to 4. After answering those questions, candidates will select one of the four divisions offered

and stay by that. No credit will be given to a candidate in any division who undertakes to answer questions in more than one division.

FISH INSPECTOR

Technical

1. What, in general, do you consider to be the duties of a Fish Inspector?

2. What fish are most commonly sold in New York markets? What are the principal seasons for each, and what, generally, the main source of supply?

3. How do you test canned fish and oysters without opening the cans?

4. What tests are employed for determining whether cooked and uncooked shell fish are fit for sale? Include lobsters and crabs in your answer.

5. What are the indications that fish exposed for sale are unfit to eat?

6. What objections are there to exposing fish for sale in the open air?

7. You are sent to inspect five places where fish, oysters, etc., are exposed for sale. Two of the places are found unsatisfactory, the others satisfactory. Assuming such facts as you please, write a report to the Chief Inspector, properly dated, addressed, and signed with your NUMBER and NOT your name, giving the results of the inspection and such recommendations as you think proper.

8. Describe the conditions of each of the specimens shown you and name each kind. (The candidate should make notes at the time of inspection and afterward write description in full.)

Arithmetic

1. Add. 2. Subtract. 3. Multiply. 4. Divide.

DISINFECTOR

Duties

1. Give a detailed statement of what you understand to be the duties of the position you seek.

2. Show how the proper performance of these duties is a matter of great importance to the public at large.

3. What qualification would you, if in authority, consider especially necessary for an efficient official of this sort?

4. Explain in your own words what you understand by the term disinfection.

5. What you understand by a contagious disease. Give examples.

6. It is proposed to make the corps of disinfectors a uniformed force. Discuss the advantages to the Department of Health, to the public, and to the disinfector himself should this be done.

7. Name substances in use for the general disinfection of rooms after contagious diseases and state briefly how they are employed.

8. How may floors and woodwork be disinfected?

9. If you are ordered to disinfect an apartment in a tenement house, and met with opposition from the family, how would you proceed?

10. If valuables have been left by the family in the room or rooms to be disinfected, what course would you adopt to protect yourself?

Arithmetic

1. Add 3 1–4, 7 1–3, 8 2–5, 9 7–12.

2. Multiply 78 094 by 60.98.

3. Divide 33.12858 by 789.4.

4. What are the cubical contents of a room 14 feet 6 inches wide, 20 feet 4 inches long, and 8 feet 3 inches high?

Experience

1. State age and place of birth.

2. Describe fully the educational advantages you have had.

3. How have you been employed for the past five years? If you have changed your employment during that time, state fully the reasons for doing so.

4. Give any details which would show that you were especially trusted by your employers.

5. From what contagious diseases have you suffered?

6. Have you had any experience in nursing the sick, in practical disinfection, or in the handling of chemical substances? If so, what?

DIETITIAN

Duties

1. What food principles constitute a complete diet for man? Illustrate with the proximate principles of milk.

2. Mention the important digestive secretions, and explain briefly the functions of each in digesting the various food principles.

3. (*a*) What articles of food are most difficult to eliminate in diabetic feeding, and what are the substitutes therefore?

4. Discuss the value of alcoholic beverages as food.

5. What details would you insist in teaching nurses to serve a bed-patient's food in order that the service be dainty and appetizing?

6, 7. Outline a course of lectures to pupil-nurses on the subject of diabetics to be given with practical work, stating length of course adequate and topics to be treated at each lecture.

8. Discuss the digestibility of uncooked eggs, of beaten eggs, and eggs prepared in various ways.

9. (*a*) Explain the "raising" of bread by yeast. (*b*) In what food principles are breads generally lacking? (*c*) Discuss the relative food value of whole wheat and of white bread.

10. (*a*) What are cereals? What leguminous food? Discuss the food value of each. (*b*) Why are the coarser vegetables indigestible? Explain how digestibility is increased by cooking.

Arithmetic

1. Add.

2. A tea merchant mixes 40 pounds tea at 45 cents per pound with 50 pounds at 27 cents per pound. He sells the mixture at 42 cents per pound. What per cent profit on the cost does he make?

3. The yard measure of 1758 was 36.00023 inches long. How many of such yards would there be in our mile of 62,360 inches?

4. A man sold one-third of a bag of coffee, then one-half of it, and took home the rest—12 pounds. How many pounds did he have at first?

5. A gardener raised four-fifths of a bushel of beans in one patch and seven-eighths of a bushel in another. He sold 3 pecks, 6 quarts, 1 pint. How much had he left?

MEDICAL INSPECTOR

1. Differentiate smallpox from each of the following diseases, stating stages or types which each might stimulate: (1) measles; (2) varicella; (3) typhus fever· (4) the pustular syphilis.

2. Give physical signs of lobar pneumonia and state how they differ from those of pleurisy with effusion.

3. Mention four etiologically distinct contagious skin diseases, and describe briefly the characteristic dermatological appearances in each.

4. Differentiate between malignant, ulcerative, or mycotic endocarditis, and the infectious disease possibly stimulating it.

5. Describe briefly the organism or malarial infection, its types, transmissions, and bearing of these facts on prophylaxis.

6. In what ways is the plumbing of a house apt to be defective?

7 and 8. (*a*) Give clinical history of scarlet fever up to the fourth day of the disease; (*b*) tabulate possible complications of the disease; (*c*) tabulate important sequelæ of this disease; (*d*) if in authority in an individual case, what steps would you insist upon to prevent spread? (Give details.)

9. What are the causes of (*a*) hæmatemesis; (*b*) hemorrhagic (petechial) rashes; (*c*) of what value is the pressure or absence of leucocytosis in differential diagnosis of infectious diseases?

10. What are the diagnostic symptoms of yellow fever and what is the present belief as regards its transmission by fomites, etc.?

INSPECTOR OF TENEMENTS

Technical

1. State clearly, concisely and precisely, the conditions of living in New York City which have made necessary the establishment of a Separate Tenement House Department.

2. Suppose a fashionable apartment house, five stories high, with two apartments on each floor. There are no kitchens in any apartment, but there is a restaurant on the ground floor. Some of the tenants introduce gas ranges into their apartments. Does this action make a tenement house of the place or not? Give reasons with your answer.

3. Explain the meaning of the words " superficial area " in the provision that " the total window area in each room, except water-closet compartments and bathroom shall be at least one-tenth of the superficial area of the room."

4. State for what purposes (*a*) a tenement house or a part thereof may not be used for business or storage; (*b*) for what it may be used under certain restrictions; (*c*) what these restrictions are; (*d*) what is " wire glass " and " fire-proof material " as applied to walls and ceilings?

5. Define " cellar " and " basement " and state as precisely as you can all the purposes to which the law allows them to be put and under what conditions.

6. State the laws governing fire escapes; how they must be constructed; where placed; whose duty it is, apart from the tenants, to see that they are kept clear and in good condition.

7. What is meant by a " trap " in plumbing? Why is a trap necessary in a water-closet? What is the provision of the Sanitary Code as to

trapping sinks, etc? What is meant by "siphoning," how is it caused, and how best prevented?

8. What are the duties of an owner or tenant with reference to the sidewalk upon the premises of which he is owner or tenant? State one instance in which the law governing this matter has been conspicuously disregarded in the past few weeks. Upon what city department does the responsibility of this matter rest?

9. State the reasons why a water-closet flush should not come directly from the supply pipe.

10. Taking in order, tubs, drains, ventilation pipes: State the best materials for each and indicate the objections to other materials sometimes used.

11. State as concisely as possible, the conditions in existing tenement houses (*a*) which are allowed to continue; (*b*) which must be changed in case of alteration; (*c*) which must be changed if not altered; (*d*) which will not be allowed in houses to be hereafter erected; and give briefly your opinion for the reason of the law in each case.

12. You are sent to inspect (*a*) a tenement house of ordinary character, five years old; (*b*) a tenement house in process of construction; (*c*) a tenement house of the so-called "model" character, one year old; state precisely to what points you would direct your investigations, and assume any facts you please, write a report of your inspection, addressed to the commissioner. N. B.—Sign this report with your examination number and not your name.

13. Suppose that in case (*a*) of question 12 you discovered some conditions or violations of the law, not of a very serious character, but created by the tenants themselves. What would be your course toward the tenants? Would your course be in any way determined by any of the following: nationality; length of residence in the city; means of subsistence; comparative ignorance? If so, how and why?

14 and 15. See the annexed plan.

INSPECTOR OF TENEMENTS

Special Paper

1. Enumerate the evils which are likely to arise from over-crowding in tenement houses.

2. Suppose a fashionable apartment house, five stories high, with two apartments on each floor. There are no kitchens in any apartment, but the occupants take their meals in a restaurant on the ground floor. In the summer the restaurant is closed for several months for

repairs. Some of the tenants then prepare their own breakfasts in their apartments. Does this action make a tenement house of the place or not? Give reasons with your answer.

3. Explain the meaning of the following terms: "Gooseneck ladder," "winder," "string" in stairways, "louvre."

4. State the principal changes made in the Tenement House Law by the amending act of 1902.

5. Under what conditions may a cellar be occupied for living purposes?

6. What is the provision of the law as to stairways on non-fireproof tenements to be hereafter erected?

7. If in making an inspection you should find tenants beating a carpet on a roof or hanging it out of windows, what would you do?

8. What are the requirements as to lighting public halls in tenements? (This question refers both to windows and artificial lighting.)

9. In what way is the height of a tenement house determined by the width of the street on which it is built?

10. What restrictions are there as to building rear tenements?

11. Why is it forbidden to connect the waste pipe from a bath-tub with a water-closet trap?

12. Why is it required that plumbing work under water-closets should be uncovered?

13. You are sent to inspect three tenement houses of different character. In some instances you find violations of the law as to construction, and in some violations of the Sanitary Code. Assuming such facts as you please, write a report, addressed to the Commissioner.

INSPECTOR OF TENEMENTS

Technical

1. What evils, sanitary or moral, have existed in the past, not reached by previous city departments, which the Department of Tenement Houses is expected to correct? Answer this question completely, but concisely.

2. Give your opinion as to what makes the difference (*a*) in general language, (*b*) in legal terms, between an apartment house and a tenement house.

3. Explain, so that an ordinary person can understand, the meaning of the following requirements of the Tenement House Law concerning fire escapes: "The platforms or balconies shall be constructed and erected to sustain safely in all their parts a safe load at a ratio of four to one of not less than eighty pounds per square foot of surface."

4. What are the restrictions with reference to bakeries in tenement houses? What do you understand to be the meaning of "fireproof materials" in connection with such restrictions? What are the "other dangerous businesses" as to which there are restrictions, and what is the meaning of the technical term used in the law with reference to them?

5. State clearly the difference between a court and a yard, and also the differencc between a céllar and a basement.

6. The law provides that stairways on a fire escape shall be placed "at an angle of not more than sixty degrees." From what line is this angle determined? Define the following words used in the same connection: "Gooseneck ladder," "battens," "clear head-way," "tread," "string," "bracket."

7. Suppose an apartment with a kitchen sink, a water-closet and a wash-basin. How many traps are necessary? State reasons for your answer. What, if any, differences in the plumbing arrangements would be necessary if the apartment were supplied with water from the street main or from a roof tank?

8. State the rules or ordinances concerning the location and condition of fire escapes. If fire escapes are used as storage rooms, or as places for keeping flowers or the like, whose duty is it, apart from the Tenement House Inspector's, to see that they are kept clear? If you saw such a case, what would you do?

9. What objection is there to enclosing plumbing fixtures with woodwork? In the city of Paris all gas pipes must be exposed. Do you consider this a reasonable rule or not? Give reasons with your answer.

10. Taking the ordinary tenement house, state what material, you consider best for the following named purposes: Leaders, tubs, floors, partitions where there are windows and the windows themselves, drains, and give, in each case, your reasons.

11. State clearly the distinction made in the application of the Tenement House Law between houses already erected and those to be hereafter erected.

12. Draw up what you consider to be a proper blank form of report for a Tenement House Inspector, and, assuming three different buildings and conditions, make out a full report in each case.

13. How often do you think an inspection should be made? Would the character of the tenants make any difference in this matter? Would the particular points to which your inspection was directed be determined in any way by consideration of nationality, length of residence, means of subsistence or similar considerations? If so, state clearly how and why.

TENEMENT INSPECTOR

Technical

1. Name the bureaus of the Tenement House Department, and state in a general way the difference in the duties of inspector attached to the different bureaus.

2. (*a*) If the owner of a private dwelling desired to add a story to or otherwise enlarge it for the use of his family, where would plans have to be filed and permission obtained to make the alterations? (*b*) In case the owner desired to alter the building to make it accommodate four families, what different steps must he take?

3. State the difference between yard and court as used in the Building Code; also between cellar and basement, and under what condition may a cellar be occupied for living purposes?

4. What is the rule as to the height of a new tenement house under the present law and how are height, length and breadth of such a building measured?

5. State fully the requirements as to windows in rooms under the Tenement House Law. What window area would be necessary in a room thirteen feet long, fifteen feet wide and nine feet high?

6. What is an " intake " and what is its object? What area must the intake have for a court thirteen feet by twenty-six feet?

7. What are the special advantages of so-called " open plumbing?" Would it be well, in your opinion, to extend the requirements of the law to gas piping? Give reasons for your answer.

8. To what extent has the requirement as to inner courts been changed by recent amendments of the Tenement House Law? Give minimum measurements of such courts under the original law, and as changed by amendment.

9. What advantage is gained by requiring careful registration of agents and owners of tenement houses? How may an owner or agent be considered to have permitted the use of tenement property for illegal purposes in spite of his denial of the same?

10. State clearly the distinctions made in applying the Tenement House Law to buildings already erected and those hereafter to be erected.

11. Under what conditions, if at all, may a tenement house be erected on the rear of a lot on the front of which lot there is already a tenement house standing?

12. Define a fireproof building, according to the requirements of the present Building Code of New York City. What is meant by skeleton construction, and when must a tenement house be made fireproof?

13. Make a full report of your inspection of three tenement houses, assuming such conditions as you deem fit in each case.

14 and 15. It is proposed to erect a tenement house 57 feet high with the dimensions shown on the plan below. State whether this is lawful or not. Give reasons clearly for opinions. The lot is an interior lot.

INSPECTOR OF LIGHT AND VENTILATION

1. There are certain natural forces acting to produce ventilation in buildings; what are they? (Note: This does not refer to windows, ducts, courts, shafts, etc., which are only helps to ventilation.)

2. (*a*) Define what you mean by ventilation. (*b*) Can you have proper ventilation without light? (Give your reasons.)

3. (*a*) State what must be the cubical contents of an apartment for every person occupying the same. (*b*) What do you understand by an apartment? (*c*) State the minimum dimensions allowed for a bedroom in a tenement yet to be built. (*d*) State the same in an existing tenement.

4. State the difference between 7 square feet and 7 feet square, and show how you obtain it.

5. (*a*) Would the light radiating from a point be more intense or less intense as you move from it? (*b*) State the law governing the relative intensity of a light at two differing distances from the light.

6. (*a*) Is the purity of the air in a room dependent upon the size of the room or the amount of fresh air entering it? State which. (*b*) If the latter, about how much air should be supplied per minute for each individual occupying the room?

7. (*a*) State fully and clearly the arrangement and exact dimensions required of a window in an existing tenement. (*b*) State the law governing the size and arrangement, and the minimum size allowed in tenements yet to be built. (*c*) State how windows must be measured. (*d*) State what the windows of every room in a new tenement must open upon. How does this differ from that for tenements now existing?

8. (*a*) Give an exact definition of the outer courts of a tenement and their sizes. (*b*) Give an exact definition of the inner courts of a tenement and their sizes. (*c*) Why were the narrow courts previously in use not considered of sufficient size?

9. What provisions are made in the new law for the ventilation and cleanliness of shafts and courts? State fully.

10. A room is 13 feet 10 inches long and 9 feet 6 inches wide. It has

one window 2 feet 10 inches wide. How high must the window be to conform to the law for new tenements?

11. (*a*) A street is 70 feet wide. How high may a new tenement facing upon it be built? (*b*) State exactly how and where this height must be measured.

12. The law requires for every tenement on an interior lot, a certain amount of vacant space not built upon; is this space the same in area as a yard, or of what is it constituted?

13. (*a*) How many kinds of shafts are provided for in new tenements? (*b*) Which of these, if any, may be covered, and under what restrictions?

14. (*a*) What must be the minimum area and least dimension of a vent-shaft in a new tenement 48 feet high? (*b*) What must be the minimum size and area for a vent-shaft in an existing tenement, and under what conditions may this be reduced? (*c*) What rooms may have windows opening into vent-shafts?

INSPECTOR OF PLUMBING, LIGHT AND VENTILATION

Technical

1. (*a*) Give the rules governing the open space required on every lot occupied by a tenement house or a lodging house. (*b*) Define what constitutes a tenement house and also a lodging house.

2. Give the rules governing the light and ventilation of every sleeping room in such houses.

3. (*a*) Is there any difference between the expression " three feet square " and " three quare feet," and if so, what is it? (*b*) What do you mean by percentage in the expression 65 per cent, of a lot surface?

4. (*a*) What is the least area allowed in all shafts and courts? (*b*) Under what conditions may such shafts be covered? (*c*) How must all halls be ventilated?

5. What are the least cubical contents allowed in sleeping rooms?

6. Name, without describing them, all the pipes in a system of plumbing in a tenement house, giving them in order from the top of the building to the connection with the sewer.

7. State all the ways in which such a system, when thoroughly good as put in, may afterward be damaged, either during construction of the building or at a later period.

8. Describe a thoroughly good " house drain," including in your description everything which must be done to prevent leakage and stoppage, and to make it durable and efficient in every way.

9 and 10. (*a*) Describe the "vent-pipe" in a tenement. (*b*) State where the branches should be attached at each closet and the other requirements for making the branches effective. (*c*) State where the vent should be attached to the soil-pipe at the upper end (if it is so attached), where at the lower end, the method of such attachment, and all the requirements of a good job.

11. Describe the fresh-air pipe, including the proper terminations to make it most effective.

12. State, as far as you can, all the methods pursued by dishonest workmen or employers in "scamping" work.

13. Describe the best method of testing a system of plumbing; give full details.

14. What constitutes a good and sufficient flushing system to a water-closet?

15. (*a*) Describe a "soil-pipe" in a large tenement. (*b*) How it should be supported. (*c*) How it should be terminated at the top. (*d*) How it should be attached to the house drain.

Arithmetic

1. Multiply 8 feet 5 inches by 17.
2. Divide 165 feet 7 inches by 6.
3. What is the area of a lot having parallel sides 102 feet 6 inches and 98 feet 4 inches, the width being 18 feet 4 inches?
4. A room is 12 feet 8 inches by 15 feet 6 inches by 9 feet 9 inches in height. How many persons should be allowed to occupy the room, allowing 400 cubic feet of air for each person?

CLERK

Technical

1. The latest amendments to the Tenement House Law aim to improve the safety, health and comfort of occupants of tenement houses. On what general lines is this accomplished?

2. Before a tenement house can be constructed or altered, what information must be furnished to the department?

3. Name the plans necessary to determine whether a proposed tenement house complies with the law.

4. Does a fireplace and chimney affect ventilation? State your reasons.

5. A tenement house is to be built on a corner lot 75 feet wide. What

per cent of the lot may be built upon? In determining this, at what elevation is the measurement taken?

6. How deep must a yard be for a tenement house 75 feet high, built on an interior lot? Where is the measurement taken?

7. What must be the window areas in (*a*) a living room 13 feet by 10 feet? (*b*) a bedroom 10 feet by 8 feet? How must the windows be otherwise arranged?

8. What is the distinction between courts on the lot line and other courts as to size?

9. What is the distinction between different kinds of courts as to location and relative size?

10. How does the height of a tenement house affect the portions of the lot not built upon? State what these portions are (detail figures not required).

11. What is a vent-shaft? How is ventilation assisted in a vent-shaft? What are the general sanitary provisions for vent-shafts?

12. How are vent-shafts provided over stair-wells?

13. Write a letter (not less than one-half nor more than one page) to an assumed superior regarding an examination of a set of specifications, and the discovery that they do not comply with the law, assuming such facts as you please.

14 and 15. Ground plans of a tenement house, five stories high, on an interior lot, 25 feet by 80 feet. The shaded part represents the buildings. State in what particulars, if any, the law is not complied with. Give your reasons, and any figures necessary.

SANITARY INSPECTOR—HEALTH DEPARTMENT

Technical

1. What are the duties of a lay sanitary inspector?

2. How should the waste-pipe of a refrigerator or water tank be connected?

3. What points would you observe when inspecting a water-closet?

4. What defects would you look for when inspecting the iron pipes in a building?

5. When may a cellar be used as a dwelling?

6. What does the Sanitary Code require in the case of privy vaults? Manure vaults?

7. How many cubic feet of air space must be allowed to each person in a sleeping room?

8. Define tenement house.
9. Define lodging house.
10. Define cellar.

State Deputy Factory Inspector

Describe the organization of the State Department of Labor.

What are its powers?

Of what bureaus is it composed?

Define the terms *employee* and *employer*, as used in the General Labor Law.

Define the terms, *factory* and "*mercantile establishment.*"

What officials are charged with the enforcement of the General Labor Law?

State the substance of the Eight Hour Law (Section 3). To whom does it not apply?

State all possible exceptions in the application of the Eight Hour Law.

What do you understand by the term "extraordinary emergency," as used in the Eight Hour Law?

State the reason for the non-enforcement of the "prevailing rate of wages" clause.

What penalty is imposed upon contractors for public work who violate the Labor Law? How is such penalty to be enforced?

Describe the manner in which wages are required to be paid and state the intervals of payment with exceptions.

Outline the penalties for the voilation of the law in this repsect.

In what case or cases is the assignment of future wages invalid?

State the provisions of the law regarding seats for female employees. To what forms of employment does this apply?

What safeguards are required in the interest of employees using scaffolding in any form?

Describe the precautions that are required to protect from injury persons engaged in building construction in cities.

What are the duties of a factory inspector?

What is required of applicants upon obtaining work?

What do you understand by "indenture of apprentices?"

What are the age limits in the employment of minors?

What is required before a minor between the ages of 14 and 16 may be so employed?

State the requirements of the law as to certificate and school attendance.

What is a vacation certificate?

Describe the register of employed children that is required by law.

What are the time limits in the hours of employment for women and children? Describe the notice that must be posted in accordance with this clause of the law.

For what purpose may the hours of labor for women and minors be lengthened? How is this done?

Give a summary of the requirements of the law for the protection of employees in the following particulars: Elevators, hoisting shafts, stairs, stair-wells, doors, machinery, vats, etc.

Describe the requirements of the law as to fire escapes on factories. What are the powers of the factory inspector in this respect?

What provision for air space and ventilation must be made in all factories?

Give the necessary measurements of work-rooms.

What must be done in case of accident, both by employers and factory inspectors?

What is a tenement house? What is necessary before manufacturing may be carried on in a tenement house?

State the substance of the amendment of the current year relative to the licensing of tenement manufacture.

What goods may be made in a tenement after a license has been procured?

Compare the General Labor Law and the Public Health Law (L. 1893, Chap. 661, Sec. 28).

Under what circumstances is night work allowed in a tenement?

What is a "sweatshop?"

Describe the sanitary regulations that affect sweatshops.

What class of persons is exempted from the application of the sweatshop law?

What is the penalty for unlawful manufacture in tenements?

How are goods so made to be marked?

What powers have the health authorities relative to tenement-made articles?

In what way is an owner responsible for illegal manufacture in a tenement?

State the maximum hours of labor in bakeries and confectionery establishments.

How are such establishments to be kept in a sanitary condition?

Outline the law affecting sleeping places, washrooms, and similar rooms in bakeshops.

What is the State Board of Mediation and Arbitration? Outline its duties.

How may differences between employers and employees be settled in accordance with law?

State the hours of labor for women and minors in mercantile establishments.

To what sections of the State is this article (XI) of the law confined?

What employment of children is permitted during vacation periods? What is required as a vacation certificate?

Described an employer's registry of children.

What seating facilities are required for women in mercantile establishments?

Compare the various provisions of the law that provide seats for women.

What is a contract?

What do you understand by contract labor?

What is the penalty for unlawfully dealing in convict-made goods?

Outline the penalties for the following violations:

(1) Failure to pay wages when due.

(2) Failure to furnish seats for female employees.

(3) General violation of the labor law.

(4) Illegal acceptance of a fee by a State employment bureau.

What is the difference between a misdemeanor and a felony?

What employments are prohibited for children?

Who is held responsible for the illegal employment of a child?

Outline the Compulsory Education Law.

Who is charged with its enforcement in New York City?

Describe the penalties for the unlawful employment of children.

What labor is permitted on Sunday? How is the law modified for persons observing another than the first day of the week as the Sabbath?

In what ways are employees protected against coercion by employers in the right of independent suffrage.

In what way, if at all, may a workingman's tools be attached for debt?

What do you understand by the term, preferred creditor?

What is the nature of the claim of an employee for wages in a case of assignment for the benefit of creditors?

What is a mechanic's lien?

How does it operate to protect laborers on real property?

Outline briefly the general mechanic's lien law.

What is the meaning of the expression, "industrial education," referring to Section 70, Chapter 272, Laws of 1896?

What must be contained in an indenture? Define an indenture.

By whom must an indenture be signed?

What penalty attaches to the failure of a master or employer to fulfil an indenture?

May a contract with apprentices in restraint of trade be enforced?

Outline 927–928, Code of Criminal Procedure, as to proceedings in indenture cases.

What trades must be licensed in New York City?

How are such licenses issued?

Outline in general terms the liability of employers for risk on the part of or injury to employees.

MILK INSPECTOR

Special

1. State what you understand by the following terms:
   (1) Colostrum.
   (2) Strippings.
   (3) Foremilk.
   (4) Pasteurization.
   (5) Skimmed milk.
   (6) Sterlized milk.
   (7) Condensed milk.
   (8) Casein.

2. (*a*) What is the approximate chemical composition of pure milk? (*b*) What are its physical appearances and characteristics? (*c*) What is "adulterated" milk of the Sanitary Code? (*d*) What are the standards of richness insisted upon for salable milk?

3. What is an infectious disease? Mention some which may be certainly or probably transmitted by milk? State any other dangers which may arise from the sale of improper milk.

4. What are bacteria? State any facts you can about their rapidity and possibilities of growth, and the conditions which favor or retard their growth.

5. Describe a cream-gauge and show its uses. Describe a lactometer and show its uses.

6. (*a*) State briefly the duties of a milk inspector assigned to duty within the city limits. (*b*) State briefly the duties of a milk inspector

assigned to duty outside city limits. (*c*) What should be the equipment of each?

(7) (*a*) What powers has the city, as represented by the Department of Health, to regulate the management of dairies outside city limits? (*b*) If you, as an inspector, were refused admission to such a dairy, what would be your rights in the matter, and how would you proceed?

8. If assigned to inspect milk exposed for sale, indicate how you would go about it, and the point on which you would lay especial stress in declaring it salable or otherwise. If in doubt of the purity of the milk, what would you do?

9. Why is it essential that the water-supply of a dairy or creamery should be free from all possible contamination? If this supply be from a well or running stream, what points would you investigate as bearing on the possibility of pollution?

10. (*a*) What are considered desirable features in the construction and arrangement of a dairy? (*b*) Discuss the methods to be observed in milking and the care of the milk immediately afterward? (*c*) Discuss the temperature at which the milk should be kept after leaving the dairy until it reaches the consumer. (In each answer give your reasons therefore.)

11 to 14. You will be given four specimens of milk. Indicate under the number of each specimen your findings and deductions from same as to the character of the milk.

Report

A stable containing 34 cows is found upon inspection to be as follows: Building of wood, size $60' \times 25' + 9'$, two windows on a side, 2×2 door in one end, wooden floors and cow-beds with saturated earth beneath, hay stored on loose boarding overhead, cesspool 4 feet deep and 3 feet in diameter 10 feet from barn, 75 feet from this a dug well, 25 feet from which water is pumped into tank above stable. Milk immediately strained into cans standing in front door and taken to back porch of house and bottled.

Write a report of at least two pages with recommendations. Sign this report with your examination number and not your name.

LAY SANITARY INSPECTOR

Special

1. What kind of tenements must be fire-proof? What are the most common fire-proof materials? Describe how these materials are to be used in (*a*) Floor construction; (*b*) partitions; (*c*) the casing of posts, girders, trusses, etc.

2. (*a*) Where and how must concrete be used in tenement house construction? (*b*) What constitutes good concrete? Describe one way of making it.

3. (*a*) What are the provisions of the Tenement House Act in reference to windows in living rooms of tenements for purposes of light and ventilation? (*b*) What is wired glass and for what is it chiefly used? (*c*) Name two parts of a tenement house which must be painted in light colors, giving the reasons.

4. (*a*) What are the principal objections to earthenware house drains? (*b*) Under what conditions may a house drain be connected to two buildings? (*c*) In what way must openings in pipes be closed after a fixture has been removed? (*d*) In setting cast-iron drain pipes, it is discovered that several have blowholes. In what manner and under what restrictions may such holes be plugged?

5. (*a*) How must joints in iron drain pipes be connected? (*b*) In what manner must connections of lead pipes be made with iron pipes? (*c*) How must connections of lead waste pipes be made? (*d*) In a bath-room it is proposed to place a trap three feet away from a water-closet that it may be connected with the waste pipe from a bath-tub. State whether this is permissible, giving your reasons.

6. What is the remedy in each of the following cases: (*a*) A tenant in an apartment house is annoyed by odors arising from garbage and stagnant water in an adjoining vacant lot. (*b*) The noise of machinery in a printing establishment disturbs the rest of tenants in adjacent houses.

7. (*a*) How should you test a trap with a view of finding out whether its seal is lost or not? (*b*) How should the scent or peppermint test for plumbing be applied?

8. (*a*) Give briefly the provisions of the Tenement House Law in regard to railings of fire escapes. (*b*) What is meant by each of the following: filling in bars or standards, angle iron, cast iron?

10. (*a*) If an order has been issued by the Tenement House Department that a school sink be removed, state fully what is to be done

before the violation is dismissed. (*b*) Compare from a sanitary standpoint a long hopper and a short hopper closet, drawing a rough sketch of each.

Report

Give all the figuring on the ruled sheets.

To be finished by 4 o'clock.

A complaint has been made to the Tenement House Department that the water-supply in a certain tenement house is inadequate. You are sent to investigate the matter. Assuming such facts as you please, make a detailed report of the result of your investigation, give all the essential particulars and make such recommendations as you deem necessary.

Special

1. (*a*) In what manner must the stair-halls of tenements four stories in height be enclosed? (*b*) What may be the construction if the tenement does not exceed three stories? (*c*) What is the composition of mortar for building purposes? (*d*) What is metal lath?

2. What are the essential points of differences between brick and terra-cotta as regards (*a*) Composition; (*b*) method of manufacture; (*c*) uses; (*d*) durability?

3. (*a*) How would you determine when it is necessary to use damp-proofing in tenement construction? (*b*) Mention the materials most commonly used in damp-proofing and describe the way in which they are used.

4 and 5. Explain briefly but clearly the functions of each of the following: (*a*) House drains; (*b*) running traps; (*c*) soil-pipe; (*d*) vent-pipe; (*e*) main waste pipe; (*f*) rain leaders; (*g*) fresh-air inlet; (*h*) house seal.

6. Name five different conditions which would render a house uninhabitable during alterations and necessitate the issuance of a vacation notice by the Tenement House Department.

7. (*a*) In what manner must the waste pipes of tenements be ventilated? (*b*) How may an attempt be made by a plumbing contractor to avoid complying fully with this regulation? (*c*) What test may be made to see that the law is complied with in this respect and how it is applied?

8. (*a*) What are the most common causes of escaping sewer gas in tenements? How can these be remedied? (*b*) What is siphonage? How is it caused and prevented?

9. (*a*) Name five kinds of wood most commonly used in building construction. (*b*) What is the cause of dry rot in woodwork and in what part of a tenement does this most frequently occur? (*c*) What recommendations would you make as tenement house inspector under these conditions?

10. (*a*) Draw a rough sketch of a properly constructed water-closet to be erected in the yard of a tenement house. (*b*) Name three materials which may be used for water-proofing the floor of this closet, giving a brief description of each.

Report

To be finished by 4 o'clock.

You are sent to investigate the condition of the water-closets in a certain tenement house, the ground floor of which is occupied as a saloon. Assuming such facts as you please, make a detailed report covering such defects as you may have discovered, and suggest such improvements as the case seems to demand.

FOOD INSPECTOR

Fish Inspector—Technical

1. (*a*) In putting up salmon in cans, what precautions must be taken so that the fish may continue sound and wholesome for as long a period as possible? (*b*) Describe a method of preserving salmon in addition to the canning process.

2. (*a*) In a general way name the local waters from which oysters may be taken for sale in New York, giving reasons for the prohibition. (*b*) Describe the method of fattening oysters, and explain the danger that may result from the fattening process. (*c*) Name five varieties of oysters usually on sale in New York, specify the manner in which the different types may be distinguished and name the waters in which each variety is raised.

3. How may you test the fitness of a salmon, as an article of food, (*a*) by simple inspection; (*b*) by handling; (*c*) by placing it in the water?

4. (*a*) How would you determine whether, in a lobster, it was placed in the hot water alive or dead? (*b*) In what way would you find out whether or not a boiled lobster was fit for food?

5. Mention any chemicals that you know to be employed for the purpose of giving fish a natural appearance, describe the method of

using such chemicals, and explain the injuruious effects produced by their use.

6. (*a*) In inspecting a boat load, tell how you would distinguish dead clams from live ones; (*b*) what course would you follow if you discovered many dead clams in a boat load?

7. (*a*) How would you determine that a frozen fish was good for food? (*b*) How long can fish be left in cold storage without losing their nutritive qualities?

8. Write a report describing the results of an inspection of a quantity of fish which you found on sale in Fulton Market and were obliged to condemn as unfit for food.

9. Give the name and describe the condition of each specimen shown you. (The candidate should make notes at the time of inspection and afterward write description in full arranging his answers to correspond with the number of each specimen.)

Meat Inspector—Technical

1. (*a*) Give in detail the process of curing a ham from the time it is trimmed until it is ready for shipment. (*b*) Describe a modern method of making lard on a large scale.

(2) (*a*) Explain how ordinary pork sausages are made, naming the various ingredients, showing the proportion of each. (*b*) Do the same for frankfurters. (*c*) How would you detect bad meat in sausages?

3. (*a*) How would you determine whether or not a fore quarter of beef was fit for human food? (*b*) How would you differentiate between meat that was aging and meat that was decomposing? (*c*) In a freshly slaughtered steer, where would you look for evidence of tuberculosis and how would you determine that it was infected with tuberculosis and not pneumonia?

4. Tell what you know about each of the following: (1) Stearin. (2) Measly meat. (3) Wooden tongues. (4) Septicemia.

5. What preservatives and coloring matters are used in meats? Which of these preservatives and coloring matters are forbidden for use in New York City by the Board of Health? What appearances or conditions would lead you to suspect that a forbidden preservative or coloring matter had been used?

6. What are the indications that poultry has begun to spoil? What is the appearance of a fowl affected with pip, with roup, with gapes? What artificial methods are used for keeping poultry?

7. How would you recognize meat inflation? Why is it done and what are the objections thereto? How would you be able to distinguish between a lamb and a sheep, if both were caul dressed and of the same size?

8. Write a letter to the chief inspector showing how meats are handled and kept under modern methods of cold storage?

9. Give the name and describe the condition of each specimen shown you. (The candidate should make notes at time of inspection and afterward write description in full, arranging his answers to correspond with the number of each specimen.)

Inspector Fruits and Vegetables—Technical

1. What fruits picked before ripening will decompose and not ripen? Name the fruits which after being frozen become unfit for food? Tell what you know about the transportation and marketing of pineapples and mangoes.

2. What are "pricked" potatoes? Define potato scab, blight and brown rot. If you have a cargo of barrels of potatoes to inspect of a morning, how would you proceed to do so with quickness and accuracy?

3. Tell exactly what you, as inspector, would do upon seeing offered for sale: (*a*) Figs exposed to the air and covered with flies. (*b*) Yellow "cukes." (*c*) "Nested" string beans. (*d*) Cocoanuts with one eye plugged. (*e*) Black bananas. (*f*) Rice cauliflower. (*g*) Slices of pineapples on a tray.

4. What are the differences in color and other appearances between (*a*) unripe and rotten red bananas: (*b*) discolored and "speck" pineapples; (*c*) blistered and speck tomatoes?

5. What examination would you make of the following vegetables and what conditions would cause you to condemn the same for food: Onions, lettuce, turnips, peas-in-the-pod, cucumbers, spinach, rhubarb, cabbage, and green corn?

6. What appearances and conditions in dried or evaporated apples and apricots would cause you to reject them for food purposes? What conditions would tend to cause deterioration in dried apples? You are ordered to take a sample of dried apples for laboratory analysis. Tell fully what you would do.

7. In a physical examination of the following preserved substances in glass jars, what would lead you to suspect adulteration? (*a*) Tomatoes; (*b*) pickles; (*c*) cherries; (*d*) strawberries; (*e*) raspberries; (*f*) chow-chow; (*g*) rhubarb. What does a concave head on a can indicate?

8. A carload of potatoes, crated tomatoes and yellow turnips arrives at the terminal in New York in a frozen condition. Tell what disposition you would order for these vegetables and give your reasions therefor in the form of a report to the chief inspector.

Sign this report "John Doe."

FACTORY INSPECTOR

Preparation of Reports

N. B.—Form, content, clearness, use of English, etc., will be considered in rating this part of the examination.

(1) Prepare a report addressed to the Commissioner of Labor, setting forth briefly but completely the general conditions in the supervisory district to which you have been assigned, relative to child labor in the factories.

(2) The following special matters have been referred to you by the Chief Factory Inspector: (*a*) The owners of the De Kalb Textile Company's factory have protested against an order of a factory inspector in your district "To construct and erect a new stairway connecting the several floors of the factory." (*b*) The employees of the Jones & Mason machine shop have complained that "the washroom and toilet facilities provided are unsuitable and inadequate."

Prepare a full report on each case, with recommendations.

Arithmetic

In solving problems the entire process and computation must be given.

1. How many persons can be employed in a room $54' \times \frac{1}{2}' \times 11'$ if 250 cubic feet of space are allowed for each person?

2. How many yards of silk $\frac{3}{8}$ of a yard wide will it take to line $4\frac{1}{4}$ yards of broadcloth $1\frac{1}{8}$ yards wide? What will it cost at 75 cents a yard?

3. At an election A and B were the only candidates, the whole vote cast was 6235 and A was elected by a majority of 647. How many votes did each candidate get?

4. 2500 pounds of coal lasts a family 14 days. If coal is worth $6.75 per ton of 2000 pounds, what will the supply of coal required by the family from October 1, 1906 till March 31, 1907 inclusive cost?

5. An inspector receives a salary of $1000 a year and expenses. During a certain month, he was on the road $23\frac{1}{2}$ days. His hotel bill averaged $\$2\frac{1}{2}$ a day and he traveled by rail an average of 25 miles a

day at an average expense of 2½ cents a mile. What will his total bill for salary and expenses amount to at the end of the month?

Law

1. Give the substance of the amendment to the labor law passed by the last Legislature relative to telegraph and telephone operators and signalmen. What is the purpose of this amendment?

2. What provision does the law make for the protection of employees who have to use scaffolding for building purposes? How is this provision enforced?

3. How much space must be allowed in a factory work room for each employee and what provisions are made for its ventilation?

4. State the provisions of the law relative to the employment of women and children at polishing and buffing?

5. Define a "tenant-factory" as used in the labor law. Who is responsible for the observance of the law in such tenant-factories?

6. Name at least ten articles to manufacture which a tenement house must secure a license. How is such a license secured?

7. State at least two provisions of the labor law relative to the buildings, etc., occupied by bakeries.

8. What privision does the labor law make relative to the inspection of boilers in factories and what boiler equipment or equipments are required?

9–10. State in full the main provisions of the labor law relative to the employment of minors. What must the certificate of employment required of minors contain and how is it issued?

3. Discuss fully the nature and purpose of the State factory laws.

4. Give the provisions of the Labor Law relative to the hours of labor of children, minors and women. Name the exceptions thereto.

5. Give the provisions of the Labor Law relative to recording and reporting accidents in factories. Why these provisions? State in full.

6. Why was the position of Supervising Factory Inspector created? Discuss fully.

7. The traveling carriage of a "mule" spinning machine on its outward run extends to within 9 inches of a pillar in a textile factory. In such a case what course would you, as a Supervising Factory Inspector, take? State in full. On what provisions of the Labor Law, if any, would you base your action?

8. Define (*a*) Employee; (*b*) factory; (*c*) tenement house, (*d*) employer; (*e*) tenant-factory.

9. Why are tenement houses used for manufacturing purposes required to be licensed by the Commissioner of Labor? Give reasons in full. Give the provisions of the Labor Law relative to cleanliness, sanitation

and diseases in a tenement house used for manufacturing purposes. How are these provisions enforced? State fully?

10. Under the provisions of the Labor Law relative to bakeries, how is the responsibility for conditions divided between landlord and tenant? What summary method may be used to enforce obedience to sanitary requirements? What difficulties may arise, and why?

Inspection

1. Give a list of the machinery used in the textile industry. Name the elements of danger and the best methods of guarding each machine.

2. Give a list of the machinery used in a general machine shop, the elements of danger from each machine and the best methods of guarding the same.

3. Give a list of machinery used in a wood-working establishment. Name the elements of danger and the best methods of guarding each machine.

4–5. One of your duties will be to give instructions to newly appointed inspectors. Prepare a communication to such an inspector, giving definite instructions relative to the inspection of factories, covering the subject in the following order:

(*a*) A factory inspector's duties under the law.
(*b*) Employment and hours of labor of children.
(*c*) Employment and hours of labor of minors and women, and restrictions thereto.
(*d*) Dangers incident to the operation of machinery, fire hazards, and safety appliances.
(*e*) Sanitation, and conveniences prescribed by the Labor Law for employees.
(*f*) General instructions deemed best, if any.

6. Prepare a communication to a newly appointed factory inspector regarding his duties while inspecting tenement houses.

7. A factory inspector in your district has made an inspection; notice of changes as the result thereof have been sent the manufacturer; the manufacturer appeals; what would be your duty in the matter? State specifically and fully the course you should take. Assuming necessary facts, make a full report on same to the Commissioner of Labor, including your recommendations.

8. How may accidents in factories, woodworking establishments, etc., be minimized, aside from safeguarding the machinery? Has a factory inspector any duty or obligation in avoiding accidents, aside from seeing that machines are properly safeguarded? Discuss both questions fully.

Answer all questions fully and in detail.

1. Assuming that you have been assigned to investigate a case of alleged violation of the law regulating the construction of fire escapes and have made your investigation, write a report of the same to the Commissioner of Labor.

2. What would you do if you as an inspector found a boiler in use in a factory in a dangerous condition?

3. State definitely the course you would take if you were sent to inspect an establishment claiming to manufacture "tenement made articles."

4. If you were sent to inspect a shirt factory what points would you especially notice? State definitely and fully.

5. State the objects sought to be attained by an enforcement of the factory inspection law.

6. Draw up an affidavit charging John Doe with violation of the provisions of the law forbidding the employment in factories of children under 14 years of age.

7. (*a*) What parts would you especially notice in inspecting the machinery used in a woodworking factory? (*b*) In a steam laundry?

8. What points would you look into in inspecting a passenger elevator?

9. (*a*) What course should an inspector take in case he discovers evidence of a contagious disease in a tenement factory where clothes are being made? (*b*) What diseases do you class as contagious?

10. What are the requirements of good ventilation and how would you determine whether or not a room was properly ventilated?

Arithmetic

Give all computations in full.

1. Add the following and from the sum subtract 74,297,869:

64,298,317
8,097,121
35,283,121
62,194,727
33,284,194
8,278,194
48,916
27,719,289
1,118,903
66,732
82,918,334
19,716,279

2. If 1962 barrels of potatoes can be bought for $7357.50, how much will 486 barrels cost at the same rate?

3. Find the total cost of

1789⅞ yds. of cloth at $.03 a yd.;
893 5/12 bu. of beans at $1.89 a bu.;
1962½ lbs. of sugar at $.04 a lb.;
7384 bu. of potatoes at $1.03 a bu.

4. How many cubic feet of air in a room 15½ yds. long, 14 yds, wide and 3½ yds. high, and how many persons can be employed therein if 260 cubic feet of space are allowed for each person?

5. A man receives a salary of $83⅓ per month. How long will it take him to pay for a house costing $2500 if his yearly expenses average $600?

Law

1. Describe the organization of the Department of Labor. How are appointments made therein? What is the general purpose of the State in maintaining such a department?

2. Give the functions of (*a*) The Bureau Of Factory Inspection, (*b*) the Bureau of Mercantile Inspection.

3. Give the provisions of the Labor Law relating to (*a*) Hours of labor, with the exceptions thereto; (*b*) wages. What is the purpose of these provisions? What kind of public employment is exempted from the application of these restrictions and why?

4. What are the provisions of the Labor Law in relation to the safety of persons employed in the construction, repair or renovating of buildings?

5. Define the following terms as used in the Labor Law: (*a*) Factory (*b*) tenant-factory; (*c*) mercantile establishment.

6. State concisely the provisions of the Labor Law relating to the employment of children in (*a*) Factories; (*b*) mercantle establishments? Why these provisons?

7. What are the provisions of the Labor Law relating to the employment of women in (*a*) Fatcories; (*b*) mercantile establishments?

8. State briefly the provisions of the Labor Law relating to the safety of life and limb of factory employees.

9. What provisions are made in the Labor Law for the health and comfort of employees in (*a*) Factories; (*b*) mercantile establishments?

10. What are the powers of the Commissioner of Labor with reference to unsanitary conditions in (*a*) Tenant-factories; (*b*) bakeries?

11. What are the powers of the Commissioner of Labor relative to tenement houses?

12. What class of employees are excluded from employment upon public works in this State? What further provision is there relative to preference in employment upon such works?

1-2. A complaint, received by the Commissioner of Labor alleging that a contractor for the erection of a state armory is violating the Labor Law by requiring his employees to work ten hours a day, has been referred to you for investigation. Prepare a report sustaining the complaint, and describing the facts in detail. Support your report with the sworn statements of two of the contractor's workmen who have been required to work more than eight hours a day.

3. John Smith is charged with employing children in his factory after 5 P.M. How would you obtain evidence against him with a view to his prosecution? What evidence and how much would you consider necessary?

4. What is (*a*) A line shaft; (*b*) a counter shaft; (*c*) an idler or loose pulley and a belt shifter?

5. Supplying all necessary facts, give an outline of the inspection of a machine shop containing dangerous machinery upon which boys under 16 years of age are employed. Give in connection therewith such orders as may be necessary to remedy conditions found in violation of law.

6. Supplying necessary facts, give an outline of the inspection of a knitting mill employing a large number of women and children. Assuming that the sanitary requirements for the health and comfort of employees have not been complied with, give orders to correct the defects in accordance with the law.

7. Suppose on inspecting a paper box factory in a tenant-factory, you find that the floors and toilets are in a filthy condition, that the air in workrooms is superheated and charged with unpleasant odors and that all windows are closed. Indicate the course to be taken to remedy the conditions.

8. Describe in detail the particular elements of danger of physical injury in connection with the operation of power-driven machinery while entirely devoid of safeguards. Indicate how the danger may be practically overcome without interference with the utility of such machine. Name several power-driven machines, describing the danger from each and the method of guarding against accident.

Arithmetic

In solving problems the entire process and computation must be given.

1. How many persons can be employed in a room $54' \times \frac{1}{2}' \times 11'$ if 250 cubic feet of space are allowed for each person?

2. How many yards of silk $\frac{3}{8}$ of a yard wide will it take to line $4\frac{1}{4}$ yards of broadcloth $1\frac{3}{8}$ yards wide? What will it cost at 75 cents a yard?

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CHAPTER V

CALCULATION OF AREAS AND CUBIC SPACE

In investigating overcrowding of lodging-houses or tenements, it is often necessary to find out the cubic space of rooms in order to show how many people may inhabit them. The following rules will be helpful for this purpose:

The *floor-space* of a room is the width of the room multiplied by its length.

The *cubic space* of a square or rectangular room is the width multiplied by the length, and the result again multiplied by the height.

The *area of a triangle* will be the base multiplied by $\frac{1}{2}$ the height, or the height multiplied by $\frac{1}{2}$ the base.

The *cubic space of a triangle* equals the area of the section multiplied by its depth.

The *area of a circle* equals the square of the diameter multiplied by 0.7854.

The *cubic capacity of a sphere* equals the cube of the diameter multiplied by .5236.

Projections of chimneys, furniture, etc., must be deducted from the cubic space of the room.

A grown person occupies about 3 cubic feet of space.

The minimum of air-space in a lodging-house for each individual is 400 cubic feet.

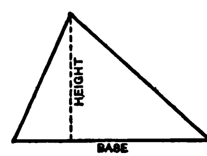
The minimum of air-space in a workshop for each individual is 250 cubic feet.

The minimum of air-space in a tenement-house for adults is 400 cubic feet, and 200 cubic feet for children under 12 years of age.

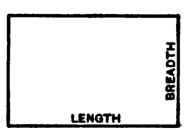
Triangle

Area = half the product of base and height.

This may be obtained by multiplying the base by the height and halving the product, or by multiplying the base by half the height or the height by half the base.



Quadrilateral of Four-sided Figures

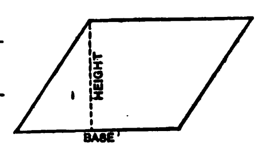


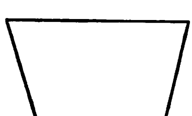
Rectangle and square (in both of which all angles are square).

Area = the length multiplied by the breadth.

Rhombus or rhomboid (in which the opposite sides are parallel).

Area = the base multiplied by the perpendicular height.



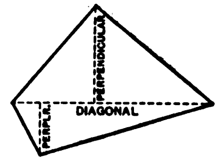


Trapezoid (in which two sides only are parallel).

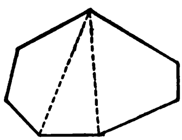
Area = the mean length of the parallel sides multiplied by the perpendicular distance between them.

Trapezium (which has none of its sides parallel).

Area = half the sum of the perpendiculars multiplied by the diagonal on which they fall.

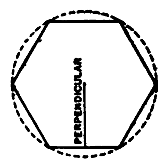


Polygons



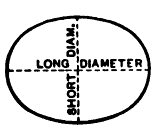
Irregular polygons may be divided into triangles $\left\{\begin{matrix}\text{or}\\ \text{and}\end{matrix}\right\}$ trapeziums and the areas found by the foregoing rules.

Regular polygons. Area = the sum of the sides (perimeter) multiplied by half the perpendicular (drawn from the center to the middle point of any side) *or* half the perimeter multiplied by the perpendicular, *or* square the length of one side and multiply by—



1.72 if pentagon (5-sided)
2.598 if hexagon (6-sided)
3.634 if heptagon (7-sided)
4.828 if octagon (8-sided)
6.182 if nonagon (9-sided)
7.694 if decagon (10-sided)

Ellipse

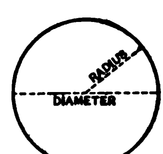


Area = the long and short diameters multiplied together and the result multiplied by .7854.

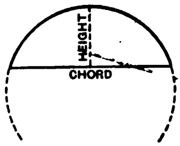
Circle

Area = square of diameter multiplied by .7854 *or* square of radius multiplied by 3.1416.

Note.—The area of a circle is equal to that of a triangle whose base and altitude are equal to the circle's circumference and radius.



Segment of a Circle

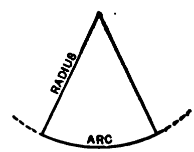


Area = the cube of the height divided by twice the length of the chord added to two-thirds of the product of chord and height, *or* the area of the sector which has the same arc, less the area of the triangle formed by the radii and the chord.

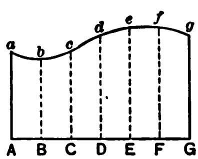
Note.—When the segment is greater than a semicircle, find the area of the circle and deduct the area of the smaller segment.

Sector of a Circle

Area = half the product of the arc multiplied by the radius, *or* length of arc multiplied by half the radius, *or* the number of degrees in the arc multiplied by the area of the circle and divided by 360.



Curvilineal Figures

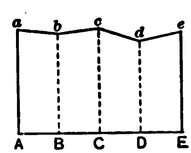


Area = the first ordinate + the last ordinate + twice the sum of all other odd ordinates + four times the sum of all even ordinates, multiplied by one-third of the distance between two adjacent ordinates.

Note.—The ordinates should be drawn equidistant and the divisions made even in number. In the figure *aA* is the first ordinate, *gG* the last, *bB*, *dD*, and *fF* the even, and *cC* and *eE* the odd ordinates.

Irregular Figures

Area = the mean of the extreme ordinates added to the sum of the intermediate ones and multiplied by the whole length of the figure divided by the number of ordinates less one.



Note.—The areas of other irregular figures may be ascertained by dividing the latter into squares, triangles, and segments, finding the areas of each of these separately, and then adding them together.

Cubic Space

Cubic space or contents is arrived at by multiplying the area of the base by the perpendicular height when the latter is uniform over the whole area. If the contrary be the case, the mean, or average, height must be ascertained and the area multiplied by it.

CHAPTER VI

USEFUL INFORMATION FOR SANITARY ENGINEERS AND INSPECTORS

(Compiled by WILLIAM KENT, M.E.)

WEIGHT OF WATER

1 cu.ft. of fresh water at 62° F. = { 62.355 lbs.; 0.03118 net ton; 7.4805 gals.

1 U. S. gal. = { 8.336 lbs.; 0.13368 cu.ft.; 231 cu.in.

1 cu.in. of fresh water = { 0.036085 lb.; 0.004329 gal.

1 net ton (2000 lbs.) = { 32.074 cu.ft.; 239.93 gals.

TABLE OF PRESSURE AND THEORETICAL VELOCITY OF WATER UNDER VARIOUS HEADS

Head of Water in Feet.	Pressure in Pound per Square Inch.	Velocity in Feet per Second.	Head of Water in Feet.	Pressure in Pound per Square Inch.	Velocity in Feet per Second.
1	0.433	8.02	17	7.361	33.1
2	0.866	11.4	18	7.794	34.0
3	1.299	13.9	19	8.227	35.0
4	1.732	16.0	20	8.660	35.9
5	2.165	17.9	25	10.825	40.1
6	2.598	19.7	30	12.990	43.9
7	3.03	21.2	35	15.155	47.4
8	3.464	22.7	40	17.320	50.7
9	3.897	24.1	45	19.485	53.8
10	4.330	25.4	50	21.650	56.7
11	4.763	26.6	55	23.815	59.5
12	5.196	27.8	60	25.980	62.1
13	5.629	28.9	70	30.310	67.1
14	6.062	30.0	80	34.640	71.8
15	6.495	31.1	90	38.970	76.1
16	6.928	32.1	100	43.330	80.2

Drainage

The velocity of the flow in drains should be from 3 feet to 4.5 feet per second.

An easy rule for determining the proper inclination at which drains should be laid is to multiply the diameter of the drain (in inches) by 10. The result will be the number of feet in which the drain should fall 1 foot; thus

4 inches = 1 in 40. 6 inches = 1 in 60.

Table of Fall Necessary to Obtain Certain Velocities (in Feet per Second) in Drains Running Full or Half Full

Diameter of Drain in Inches.	$V=2.5.$	$V=3.$	$V=3.5.$	$V=4.$	$V=4.5.$	$V=5.$	$V=5.5.$	$V=6.$
	1 in.	1 in.	1 in.	1 in.	1 in.	1 in.	1 in.	1 in.
4	129	92	68	53	42	34	29	24
5	161	115	85	66	52	42	36	30
6	193	137	102	80	62	51	43	36
9	290	206	154	119	95	77	65	54
12	386	275	205	159	127	103	86	72

Relative Discharging Power of Pipes.

(When the fall and the length of the pipes remain constant, the discharge varies as the square root of the fifth power of the diameter, or as $d^{2.5}$.)

Diameter of Pipe.	$d^{2.5}$.
2½	9.88
3	15.59
4	32.0
5	55.9
6	88.18
9	243.0
12	498.8
15	871.4
18	1375.0
24	2822.0
30	4930.0
36	7776.0

Contents of Wells in U. S. Gallons

Diameter of Well. Ft.	In.	Contents in Gals. per Ft. of Depth.
2	6	36.72
3	0	52.88
3	6	71.97
4	0	94.00
4	6	118.97
5	0	146.88
5	6	177.22
6	0	211.51

Capacity of Rectangular Cisterns

Length in Feet.	Width in Feet.	Depth in Feet.	U. S. Gallons.	Length in Feet.	Width in Feet.	Depth in Feet.	U. S. Gallons.
2	1	1	14.96	5	2½	2½	233.8
2	1½	1½	33.66	5	3	2½	280.5
2½	1½	1½	42.08	5	3	3	336.6
2½	2	1½	56.10	5	4	3	448.8
2½	1½	2	74.80	5	4	4	598.4
3	1½	1½	50.49	6	3	3	403.9
3	2	1½	67.32	6	3½	3½	550.5
3	2	2	89.76	6	4	4	718.1
4	2	2	119.7	7	3½	3½	641.4
4	2½	2½	187.0	7	4	4	837.8
4	3	2	179.5	7	5	5	1309
4	3	2½	224.4	8	5	5	1496

Formulæ for Calculating the Capacity of Drain and Other Cylindrical Pipes

D = diameter of pipe in inches.
A = area of pipe in square inches.
L = contents per foot of pipe in pounds.
F = " " " cubic feet.
G = " " " gallons.

$L = D^2 \times 0.34$ $\quad$ $L = A \times 0.433$

$F = D^2 \times 0.005454$ $\quad$ $G = D^2 \times 0.408$ (U. S. gals.)

TABLE OF VELOCITY (IN FEET PER MINUTE) AND DISCHARGE (IN GALLONS PER MINUTE) OF DRAINS WITH VARIOUS FALLS WHEN RUNNING FULL

Diameter.	4 Inches.		5 Inches.		6 Inches.	
Fall.	Velocity.	Discharge.	Velocity.	Discharge.	Velocity.	Dischagre.
1 in 20	395	257.88	441	450.48	481	707.02
1 in 25	353	230.49	395	402.62	432	634.98
1 in 30	322	210.25	360	367.28	395	580.61
1 in 35	298	194.62	333	339.97	366	538.01
1 in 40	278	181.50	311	317.05	342	502.74
1 in 45	261	170.42	291	297.71	322	473.32
1 in 50	246	160.85	278	280.98	307	450.55
1 in 60	226	147.73	253	258.07	279	409.44
1 in 70	209	136.66	234	238.72	257	377.17
1 in 80	194	126.85	217	221.59	239	350.74
1 in 90	182	118.98	203	207.84	225	330.22
1 in 100	172	112.46	192	196.45	213	312.62

Diameter.	9 Inches.		12 Inches.	
Fall.	Velocity.	Discharge.	Velocity.	Discharge.
1 in 20	582	1925.16	664	3904.97
1 in 25	525	1737.12	600	3528.34
1 in 30	481	1591.20	551	3240.80
1 in 35	446	1475.16	513	3016.91
1 in 40	418	1382.04	481	2828.96
1 in 45	395	1306.56	454	2670.23
1 in 50	375	1240.68	432	2539.18
1 in 60	343	1135.18	395	2322.04
1 in 70	317	1049.06	366	2151.30
1 in 80	296	979.43	342	2010.53
1 in 90	279	923.27	322	1892.96
1 in 100	264	873.85	306	1798.52

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